EDITORIAL

A National Congress of Engineering is now being held at Buenos Aires as a part of the celebration of the centenary of Argentine independence.

NOT long ago, as every California oil operator knows, certain lands were withdrawn from entry by the Federal Government. An interesting sidelight is thrown upon the value of some of the lands by the fact, recently disclosed, that the Government has asked for injunctions to prevent certain county officials from selling some of this property for delinquent taxes.

PORTIONS of the Hetch-Hetchy aqueduct are soon to be constructed. The division between Cherry creek and the Tuolumne river will be the first to be built. Bids for driving the tunnels will be opened on August 9. There will be six tunnels, each 7 feet 6 inches by 7 feet 6 inches, ranging from 600 to 1400 feet in length. The roofs will be arched.

OUR readers will be interested in learning that Mr. Clemens Herschel in his presidential address before the annual convention of the American Society of Civil Engineers advocated almost without change the departmental plan in public works put forth by Mr. C. E. Grunsky in his article on this subject published in our issue for April of this year.

THE American Society of Civil Engineers has voted by a large majority to move its New York headquarters to the Engineering Societies Building. All the great national engineering societies will soon be under one roof. While few of the Pacific Coast members of the Society will be directly affected by this decision, they can, however, rejoice in a change which seems destined to assist in bringing about greater co-operation throughout the engineering profession.

THE city-manager system has been in force for one year at Bakersfield, California, a town of about 15,000 people. In spite of the fact there is general agreement that the citizens are getting more return from the city than ever before, the current cost of government, exclusive of permanent improvements, bond interest and redemption, was $186,000 as against $213,000 for the year before. Particularly noteworthy is the fact that the streets are better cleaned for $12,000 per year than formerly for $26,000.

STREET-RAILWAY franchises are an important problem in most cities. Early in the history of many of our large cities, the authorities presented perpetual or long-term franchises to street-railway companies, few if any conditions being exacted. Later, when the growth of population had rendered these franchises extremely valuable, the holders assumed a 'public-be-damned' air that was worse than annoying. Other cities have tried municipal ownership, but, without prejudice, the results at least might be said to be frequently disappointing. A better plan would seem to be one that would recognize the right of the public to good service, of the company to a reasonable profit upon its investment, and that would permit the city to take over the property at any time, while safeguarding the company against confiscation. The 'indeterminate franchise' provides such a plan. To those interested in this aspect of street-railway regulation, we commend Mr. George H. Binkley's article in this number.

A Novel Solution of the Grade-Crossing Problem

Elimination of all grade crossings would, of course, be an excellent thing if it were economically possible. Mr. Alexander Gordon of the California Railroad Commission has estimated that the cost of bringing this about in California alone would be $300,000,000. The most feasible plan would appear to be to expend a definite sum for this purpose annually so that the cost could be distributed over a term of years. Provision could be made to compel grade separation on every new crossing to be installed, the burden of the expense to be borne by the new-comer. Flagmen, gates, bells, and all of the other means usually employed for preventing accidents at grade crossings, will continue to be required until the dawn of the railroad man's Utopia when complete grade separation is achieved. Every morning, the press chronicles a list of automobile accidents, 99 per cent of which were easily preventable had the drivers used the most ordinary care in handling their cars. Passing laws prohibiting speeding and reckless driving, is about as effective as trying to legislate morals into those who, unfortunately, have no moral sense. The drastic enforcement of the laws already in existence, of course, has a temporary deterrent effect upon the reckless motorist, but since the enforcement of the various speed-laws is handled in a more or less spasmodic way, accidents seem to occur in a series of waves. The load-factor is certainly in need of police correction.

Mr. Fulton Lane, president of the Board of Public Utilities for the city of Los Angeles has come forth with what might be termed an 'automatic' speed corrective. The Pacific Electric Railway has four tracks crossing Mission road near Rosehill at an oblique angle. For several reasons grade separation at this point is not feasible.

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In spite of the removal of several obstacles to a clear view, and the installation of warning bell-signals, the crossing is exceedingly dangerous, due to the recklessness of automobile drivers. Mr. Lane has suggested a 'bump,' or in road parlance, a 'thank you ma'am,' to be placed about 50 feet from the tracks, or else that a portion of the pavement be removed at that point and fine dry sand substituted, thus compelling the driver to shift gears or slow down. Should the Board of Public Works act upon Mr. Lane's suggestion, the experiment will be watched with interest, particularly by those dealers in automobile accessories who specialize on springs.

Government Aid for Highways

Federal aid for highway construction is now assured. The Bankhead Bill has passed. In it, provision has been made for the expenditure of $75,000,000 by the Federal Government during the next five years for the purpose of aiding the various States in improving the public highways. Ten million dollars has also been provided for the construction of roads and trails in the various National forests. The expenditure of funds provided for road construction in the National forests is contingent upon the consummation of a co-operative agreement between the State, county, and the Secretary of Agriculture "for the survey, construction, and maintenance of such roads and trails upon a basis equitable to the State, county, and the United States." There is a further provision that not more than 10 per cent of the value of the resources of the National forests will be available for use in that State or county in which the forest reserve to be improved is situated. Presumably, the work will be done under the supervision of the United States Forest Service. The larger appropriation for distribution to the States themselves is safe-guarded in several ways. The complete plans for each project must receive the approval of the Secretary of Agriculture. All appropriations by the Federal Government are made contingent upon the State expending an equal amount, while all roads constructed with Federal aid must be maintained by the State at its expense in a manner satisfactory to the Secretary of Agriculture, or additional Federal appropriations for this purpose will be withheld. There are also some minor provisions, such as limiting the total Federal appropriation to a maximum of $10,000 per mile.

During the present fiscal year $5,000,000 will be available, the amount increasing each year until the fifth year, when $25,000,000 is to be expended. The sums to be allotted to each State are calculated upon the following basis: One-third of the appropriation in accordance with the area of each State, one-third in accordance with the population, and one-third according to the total mileage of rural delivery and star routes. For the current fiscal year, the amount available for Pacific States will be as follows: Arizona, $65,513.52; California, $151,063.92; Idaho, $60,463.50; Nevada, $64,398.30; Oregon, $78,687.37; and Washington, $71,884.28. The total amount to be expended is fifteen times the funds available for the first year. Work is to be done under the supervision of each State highway department, subject to inspection and approval of the Secretary of Agriculture.

Agitation for securing Federal appropriations for general highway construction has been growing in force for some time, but until now has not been sufficiently strong to overcome the opposition based upon the 'pork-barrel' tendencies of practically all Federal projects for internal improvements. It would appear that the element of 'pork' has been reasonably well eliminated in the present bill. One of the worst, if not the worst feature of the present method of appropriating funds for river and harbor improvements has been that the amounts determined by Congress, were based upon political rather than economic considerations, instead of a budget prepared by competent authorities and based upon the actual needs of each project. Except for prescribing the amount to be expended in each State, the present highway measure permits no interference whatever with the judgment of the Secretary of Agriculture, which is a decided step in advance. It is possible that a measure permitting a larger allotment of funds to be expended in the more sparsely settled States would have been better, but here again political considerations would have interfered, and the present measure is probably as good as could have been expected under our present form of Government. In any event, there seems to be little danger that the money will be expended on useless projects, the stipulation that each State must appropriate an amount equal to that allowed by the Federal Government is sufficient guarantee of that.

One of the most beneficial results will come not so much from the financial assistance of the Federal Government as from the 'moral' effect upon local highway officials and the general public. The research work done by the United States Bureau of Public Roads in the way of developing methods for the construction of efficient highways, has been a strong factor in the development of sentiment in the direction of really good roads. The highways to be constructed under the Bankhead Bill will be built according to similar standards, and the effect of their construction should encourage a spirit of civic progress in many communities. The provision stipulating that roads once built must be properly maintained or further Federal appropriations will be withheld, will also help to educate the tax-paying public up to the fact that maintenance is just as important as original construction.

The expenditure of public funds in making the National forests more readily accessible is hardly less important. This work, together with a nation-wide advertising campaign, will have an effect upon the 'See America First' movement that should live long after the War is over. The expenditure of some $300,000,000 annually abroad by the socially ambitious in search of scenery and recreation far inferior to that available in the United States should become increasingly unpopular.

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REVIEW OF THE MONTH

THE bonds of the Stinson-Burrell reclamation district No. 1605 near Fresno, California, have just been sold at a nominal premium. This is said to be the first time in the history of the State that the bonds of a reclamation district have been sold at par or better. While a generally improved money-market is partly responsible for these altered conditions, the main reason is doubtless the change of attitude on the part of investors with regard to the securities of irrigation and reclamation districts. Nearly every Western State has its examples of districts with a few nearly obliterated structures marking a project that left little trace of its existence other than a cloud on the titles to the land included in the district. Now, public officials scrutinize carefully both the engineering and financial features of a projected district. This places such securities in much better standing.

THE Oregon Water Code has been declared constitutional by the Supreme Court of the United States in the case of the Pacific Live Stock Company *v.* John H. Lewis, State engineer, and the other members of the Oregon Water Board. Our old friend, the fourteenth amendment, was pressed into service, but the Court found that property was not being taken without due process of law, and sustained the Water Code on every point. This is an important decision, not only to Oregon but also to every other State where irrigation and power-development are of primary importance. The citizens of Washington, in particular, are to vote upon a Water Code which has been modeled upon the Oregon law, while in California the legislature, at its next session is to consider amendments to the present water law. These amendments will probably take the direction of Oregon practice.

HOW much does a square yard of pavement cost? One might as well ask: 'How big is a piece of cheese?,' yet many laymen compare street-improvement cost on just such a basis, without regard to the kind of pavement, the character of the traffic, and many other considerations. Even where the kind of pavement is supposed to be specified, there are wide variations. Mr. A. Prescott Folwell, chairman of the committee on standard forms of the American Society of Municipal Improvements, found that one city reported its sheet-asphalt pavement cost as $1.25 per square yard, while another city gave its cost at $3.53. Further investigation showed that $1.25 was for the pavement alone, while $3.53 included grading, setting new curbs, laying drains and rseetting manhole heads. Such figures published without any explanation are worse than useless. Mr. Folwell's committee is endeavoring to introduce a uniform system of nomenclature for municipal improvements and it is to be hoped that it will be successful.

IN another column there appears an abstract of that portion of the Army Reorganization Act relating to the formation of a National Engineering Reserve. Here at last, a practical method is provided whereby the civilian engineer can fit himself to be of service to his country in time of war. While the details, very properly, are left for the War Department to work out, the general plan is already determined. Of course, no one supposes that the civilian engineer, by virtue of his technical education, can qualify immediately for a commission. Much hard study and some field training will be necessary before those who have had no previous military experience can become of much value as officers. The military training camps, which seem destined to become a yearly event, will provide the field work, and the War Department will doubtless announce courses of study in the near future. Attention should be called to the fact that the Engineer Corps is not the only branch of the service that furnishes an opening for the special skill of the civilian engineer. The problems of manufacture, supply, and transportation, which are the particular field of the Quartermaster's Department, are mainly engineering problems, while the Ordnance Department and Signal Corps are almost entirely concerned with technical matters. In a great war, the Nation would need to call upon every engineer, and the services of those in the factories and transportation systems would be just as important as those on the firing-line.

OIL production in California continues to lag behind consumption. Since the beginning of the year the reduction of stocks has been at the rate of nearly 1,000,000 barrels per month. For the first time in several years, practically all the wells in the State are being pumped. The Standard Oil Company declares that the 'shut-in' production is negligible, while the Independent Producers Agency places it at 1000 barrels per day. Since this is less than one-half of one per cent of the present output, there is no real disagreement between the methods of the two companies. A further increase of 5 cents per barrel has been made in the price of crude oil, the basis at the well in the San Joaquin Valley fields becoming 63 cents. The increase in the cost of casing and many of the other factors affecting the cost of drilling has been almost as great as the increase in the price of oil, so that, while there is considerably more development work now than a year ago, the number of wells completed is only sufficient to compensate for the decline in production of old wells. With no important new fields being discovered, the public should recognize

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the necessity for extracting all the lubricating oil and light hydrocarbons from the crude product before using it as fuel. The burning of crude oil that has not even been 'topped' is a greater crime against conservation than granting a patent to a quarter-section to the man who has spent a small fortune in developing oil thereon.

IN the conservation of the more volatile constituents of ordinary crude oil, the Rittman, Burton, and other 'cracking' processes are destined to play an important part. In the Eastern States there are now three commercial plants using the Rittman process. The United States Bureau of Mines recently installed an experimental plant at San Francisco, and a series of experiments using California crude oils and distillates is now being conducted under the direction of Mr. C. P. Bowie. Sufficient work has been done already to indicate that the proportion of gasoline that can be recovered from the average California crude oil is as great as that from the average Eastern oil, while the lower price of the crude product in California should make this State a particularly favorable field for the process. It should be remembered, however, that a Rittman-process plant is not a complete refinery, but rather an auxiliary plant for treating crude oil so that then it can be further refined by the ordinary methods and a greatly increased proportion of the lighter hydrocarbons obtained.

THE strike question is now being voted upon by the railroad trainmen. The railroad companies have offered to submit the entire question to arbitration either by the Interstate Commerce Commission or by a tribunal selected under the provisions of the Erdman act. In this the railroads have offered to meet the trainmen more than half-way, since the railroads would have been bound by the decision of the arbitrators, while no one questions the right of an individual trainman to quit his job in case he was not pleased by the verdict of the arbitrators. Nevertheless, the trainmen have refused to arbitrate. In the earlier stages of the controversy, the questoin was whether or not the trainmen were justified in asking for a change in working conditions that virtually amounted to a considerable increase in their wages. This question the layman was not in a position to answer. The question now is: Have the trainmen the right to attempt to tie up the entire transportation system of the country by refusing to submit a dispute with their employers to an impartial tribunal? To this question there is but one answer.

CONSTRUCTION of the Moffat tunnel through the continental divide west of Denver seems likely to be commenced in the near future. It will be remembered that when D. H. Moffat commenced building the Denver, Northwestern & Pacific Railroad several years ago, this proposed tunnel was recognized as the most serious engineering and financial barrier to the completion of the line. Funds were exhausted before the tunnel could be commenced, and Moffat died with his great project uncompleted. Several unsuccessful efforts have been made to raise funds to construct the tunnel. The promoters of the present plan have obtained pledges for $5,000,000 of the necessary $6,000,000 bond issue, and are now endeavoring to raise the remaining $1,000,000 by popular subscription in Denver. When the tunnel is constructed, it would be a comparatively simple matter to carry out Moffat's original plan and continue the line to Salt Lake City through a productive region at present without railroad transportation. The present routes from Denver to Salt Lake City, both by Cheyenne and by Grand Junction, make a wide detour, and should the 'Moffat' line be completed, the time between the two cities could be reduced by several hours. It is probable that some reduction could also be made in the time between New York and San Francisco.

SOONER or later, the old system of divided responsibility and patchwork highway maintenance must become extinct in California. Although the State legislature at the last session failed to abolish it, the counties are taking matters into their own hands and already a number of them have placed entire charge of construction and maintenance-work in charge of a competent highway engineer who devotes all of his time to this work. It goes without saying that much more efficient results are being obtained by this method than through control divided among five county supervisors and then redivided among a number of road foremen, of whom few have had any real training in highway engineering. A board of freeholders is preparing a charter for Butte county. This provides for the adoption of one-man control of highway administration. Mr. S. H. Finley of Santa Ana has announced his candidacy for supervisor from the first district of Orange county. His entire platform consists of a single plank declaring in favor of placing the entire management of county highways in the hands of one central organization. Mr. Finley has been chief engineer for the County Highway Commission, which has just completed the construction of a comprehensive and economical system of paved highways. Mr. Finley cites among the advantages of central organization the ability to purchase expensive equipment which will earn its keep when applied to the construction of highways for an entire county, but which, on the other hand, a small road-district could not afford to purchase. The old system of highway administration must go, and the sooner the better, while public-spirited supervisors will be the first to welcome a change which will relieve them of a quantity of detail work along lines for which few have received the necessary training.

CONSIDERATION of relief measures for the oil operator on unpatented withdrawn lands has been postponed until Congress meets in December. With the many important measures which must be passed at this session and the desire on the part of the individual Congressman for an early adjournment in order that he may return home and mend his political fences, it was felt that to force discussion of the measure at this session would be inadvisable.

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DISCUSSION

Suggested Use for Culvert Pipe

The Editor:

Sir—I have been much interested in the brief article which appeared on page 260 of your issue of July 1916—'Manhole Construction in Quick Sand.'

This seems to be an ingenious and effective method for overcoming this difficulty, but the thought suggests itself that it might be much simplified by substituting for the heavy wooden frame work described, a section of corrugated culvert pipe.

This use of the material would be exactly parallel to one which is already fairly common in well construction in some localities. The employment of corrugated pipe in this way would make the sinking of the manholes much simpler and quicker, and would also afford a great deal more room for working or, on the other hand, make possible the use of brick work of considerably less outside diameter.

B. G. MARSHALL.

Middletown, Ohio, July 21.

Cost of Cleaning Wood-Block Pavements

The Editor:

Sir—Some time ago an article appeared in your magazine relating to the various costs of cleaning pavement, and I beg to enclose herewith data regarding the cost of cleaning creosoted wood-block pavement as compared with other pavement.

Mr. George W. Tillson, consulting engineer of the Borough of Brooklyn, New York, has stated that he has not been able to get data of value from actual experience on this subject. The following estimate is taken from a report made on street cleaning to the mayor of that city in 1907. After careful consideration of all the information available, the average relative cost of cleaning the various kinds of pavement in use in New York City under similar conditions of repair is as follows:

Kind of pavement	Cleanings per year
Sheet asphalt	100
Wood block	105
Asphalt block	115
Brick	120
Medina block	130
Granite block	140
Belgian block	150
Cobblestones	300

On the assumption of 100 cleanings per year, it may be shown that the excess annual cost of cleaning a mile of each of the pavements named with equally good results, above what it would be if sheet asphalt were substituted, would be as follows:

Kind of pavement	
Wood block	$ 26.40
Asphalt block (average condition)	79.20
Brick	105.60
Medina block	158.40
Granite block	211.20
Belgian block	264.00
Cobblestones	1,584.00

The situation in Philadelphia is described by William H. Connell, Chief of the Bureau of Highways and Street Cleaning, as follows, the figures of unit cost per 1000 sq. yd. being taken from the annual report of that Bureau for 1915:

Special tests in cleaning pavements with machine broom showed average costs of: sheet asphalt, $0.159 per 1000 sq yd.; wood block, $0.166; brick, $0.193; granite block, $0.246. These special tests include the cost of water at $0.04 per 1000 gallons. The average consumption of water per 1000 sq. yd. was 98 gallons. The quantity of dirt removed per 1000 sq. yd. was 118 cu. yd. The squeegee, used only on sheet-asphalt and wood-block pavements, showed by special test an average cost of $0.148 per 1000 sq. yd. Using a flusher, the average cost of cleaning 1000 sq. yd. of all kinds of pavements last year was $0.106 by special tests. In two districts in the city, automobile flushers are used. Flusher dirt is removed by block-men. Cleaning streets by block-men cost an average of $0.179 per 1000 sq. yd. in 1915. In arriving at the above costs of street cleaning in Philadelphia the daily cost of labor and equipment was assumed as follows: block-men, $1.50; gauge-men, $1.75; machine broom, $5.50; squeegee, $6; dirt-cart, $3.50; dirt wagon, $5; sprinkler, $5; automobile flusher, $15.

In Newark, New Jersey, according to Mr. James C. Hallock, deputy city engineer, they have not had any large amount of wood-block paving until recently. The cleaning has been done by hand only. The average cost of cleaning wood-block pavement for the year 1915 was $0.358 per 1000 square yards.

C. R. KELLOGG.

San Francisco, July 19.

Geometry of Dip, Strike, and Pitch as Applied to Oil Formations

The Editor:

Sir—In solving problems of geologic structure use is made of the factors known as dip, strike, and pitch. The dip is the maximum slope of any plane or stratum. I have found that, although engineers and geologists have methods for handling these problems, some, at least, are using means more cumbersome than necessary.

Assume that the logs of three wells are given, situated at *A*, *B*, and *C*, as in the figure. Their surface elevations are 1100, 1150, and 1000 ft. respectively. The

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bearings of the lines joining them are known from survey and are plotted to scale in the drawing. Assume that the depth to a certain recognizable stratum is 800, 1100, and 800 ft. in *A*, *B*, and *C* respectively. Assume a horizontal plane to pass through the top of this stratum at the well *A*. Let *BF* be the trace of this plane. Draw *BD* perpendicular to *BF* and with length = 300-50 = 250, the difference of elevation of stratum at *A* and *B*. The respective elevations of the stratum in the wells are 300, 50, and 200 ft. Also draw *CE*, using same scale as in the plan of the wells, perpendicular to *BF* and 300-200 = 100 ft. long, the difference of elevation of stratum in *A* and *C*. The angle *BFD* is the pitch along *BF*, and *F* has same elevation on stratum as *A*. Then *AF* is the direction of strike. *BG* is the direction of dip. To find the angle of dip draw *BD'* perpendicular to *BG* and equal

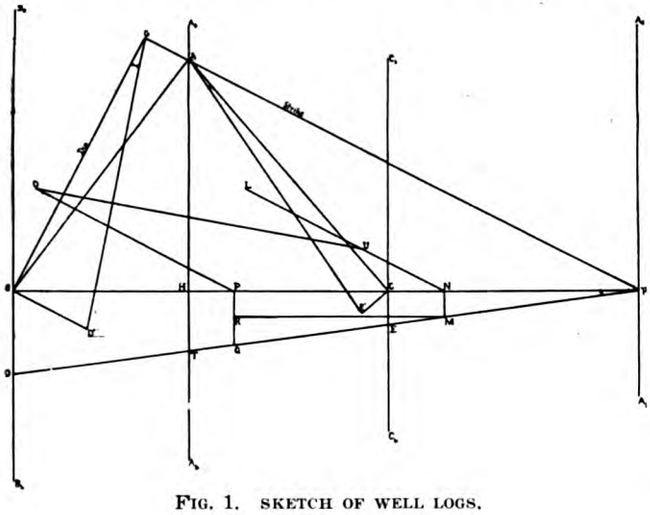

FIG. 1. SKETCH OF WELL LOGS.

to *BD*. Then *BGD'* is the required angle. To find the depth of stratum below that at *A* of any surface point, as *L*, draw *LN* parallel to strike till it intersects *BF* at *N*. Drop a perpendicular to *BF* till it intersects *DF* at *M*. *NM* is the required difference in elevation. *PQ* is the like depth of the point *O*. Then *RQ* is the difference of elevation at *O* and *L*.

Consider the problem of finding the direction along which a certain pitch of the stratum exists. Take any point as *O*, whose depth below the datum plane is *PQ*. Convert tangent of required angle to fall in feet per hundred. With *O* as a centre and a radius of 100, or common multiple of 100, describe an arc. From *Q* lay off *QR* equal to the required fall in whatever length of radius taken. Draw *RM* parallel to *BF* till it intersects *DF*. Draw *MN* perpendicular to *BF*, then draw *NL* parallel to strike till it intersects the arc at *U*. Then *OU* is the desired direction.

If it is desired to make a cross-section from the logs, a graphic log may be plotted along B_sB_b with *D* as the point of elevation of the particular stratum discussed. Log of *C* could be plotted along C_sC_b. Log of *A* can be plotted at and along A_sA_b. If the section be viewed from a distance, directly from the front and on a level with datum plane, the stratum in *A* would appear at *H* and at the same elevation as *F*. If this perspective were not desirable and well *A* was required to be thrown on section along *BF* at *H*, the log would have to be dropped down the distance *HT*. If the log of *A* were plotted along FA_s it would finish a true geologic section of the three wells along *BF*. The figure combines the features, to some extent, of plan, elevation, and stereogram. With a large-scale drawing the work may be done as accurately as is consistent with practice, and problems of most any nature, involving the elements mentioned, can be solved conveniently.

H. W. BELL.

Coalinga, California, July 5.

COMPARATIVE ELECTRICAL CONDUCTIVITY OF COPPER AND ALUMINUM.

As is generally known, copper is a better electrical conductor than aluminum; and mechanically, it is much stronger; for equal cross-section aluminum has about half the strength of copper; and for the same electrical conductivity the breaking point of aluminum wire is about 80% that of copper wire. This means that on a power-transmission line, the aluminum wire would break from 80% of the strain required to break the copper wire, assuming that neither wire was scratched or nicked. Aluminum, being quite soft, is more liable to slight mechanical injuries from erecting or handling. Sudden breaking of aluminum wires occurs from time to time by reason of injuries suffered during erection. An arc, due to a short circuit or to wires momentarily swinging together, may cause serious damage to an aluminum line on account of the low fusing point of aluminum, thus burning and pitting the wire, and reducing the mechanical strength. With copper, however, the arc has little or no effect. Aluminum is cheaper than copper when the two are compared merely on the basis of conductivity, and will furnish more conductivity for a dollar than copper. For the same conductivity aluminum is considerably lighter than copper, the ratio being 2 to 1. This might indicate that lighter towers could be used. Experience shows that the reverse is the case, because it is not the dead-weight of the line that determines the necessary strength of the tower, but the strains caused by winds.

Aluminum has a cross-section 64% larger than the equivalent copper wire, therefore offers more resistance to the wind and causes a greater side pull. Under sleet conditions a greater area of sleet will collect on aluminum than on copper, and at such times there are generally strong winds. Aluminum, on account of its greater coefficient of expansion and low tensile strength, requires higher towers, or towers placed closer together. Aluminum is not suitable when there is abrasive action on a wire, such as trolley wire, nor is it suitable for smaller sizes of wire, such as telephone wire, which is invariably of copper. Copper is better suited for cables and insulated wires on account of its smaller diameter and equal capacity.

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Timber Framing—Part III

By HENRY D. DEWELL*

Strength of Spiked, Screwed, and Bolted Joints

The strength of spiked joints in light timber framing, and of bolted joints in heavy timber framing is, perhaps, the most vital subject in timber design, yet it is a field in which but few tests have been recorded. This statement is particularly worthy of remark when applied to the resistance of bolts to lateral forces, producing bending and shear in the bolts and compression on the timber. Numerous tests have been made on the resistance of spikes and screws to withdrawal from timber, but these will not be discussed in the present article. Working values for such cases will be given in the specifications of the concluding article. For detailed information on the results of the tests that have been made, the reader is referred to the texts of Jacoby, Howe, and others.

Lateral Resistance of Spikes and Nails. The experiments on the lateral resistance of spikes and nails are in three sets, as far as can be determined.

The first series of tests was made by F. B. Walker and C. H. Cross in 1897 at the University of Minnesota. The results are published in the Journal of the Association of Engineering Societies, Vol. 19, December 1897.

The second series of tests was made by H. D. Darrow and D. W. Buchanan at Purdue University in 1898-1899, and the results are published in the Proceedings of the Indiana Engineering Society of 1900.

An abstract and review of both these sets of tests is given in Jacoby's 'Structural Details.'

The third series of tests was made in 1907 by C. K. Morgan and F. Marish, at the Iowa State College. These tests are described by M. I. Evinger in Bulletin No. 2, Vol. IV, of the Engineering Experiment Station of the Iowa State College, entitled 'Holding Power of Nails in Single Shear.'

Tables II, III, and IV show the results of these tests.

TABLE II—*Walker and Cross*

STRENGTH OF WIRE NAILS AT THE ELASTIC LIMIT OF JOINT FOR WHITE AND NORWAY PINE

Size of Nail	Strength of Nail, Lb.	Size of Nail	Strength of Nail, Lb.
6*D*	55	30*D*	226
8*D*	88	40*D*	275
10*D*	112	50*D*	342
16*D*	112	60*D*	362
20*D*	218	80*D*	500

In the experiments of Walker and Cross, the timber used was white pine, Norway pine, and oak, with average compressive strengths of 4840, 5820, and 6600 lb. per sq. in., respectively. The timber cleats in the tests were surfaced. This surfacing must have influenced the strength of the joints at the lower loads, and possibly at loads up to the elastic limit, as there is considerable friction in a tightly spiked joint with rough timbers.

TABLE III—*Darrow and Buchanan*

STRENGTH OF WIRE NAILS AT ULTIMATE FAILURE OF JOINT FOR YELLOW PINE AND OAK

Kind of Nail	Size	Yellow Pine		Oak	
		Wire	Cut	Wire	Cut
Common	2*D*	...	130	...	160
"	3*D*	...	180	184	289
"	4*D*	198	213	211	344
"	6*D*	240	317	314	429
"	8*D*	361	427	454	573
"	10*D*	724	932	762	822
"	16*D*	855	1079	891	1066
"	20*D*	930	1112	1350	1631
"	40*D*	1450	1360	1745	1874
"	60*D*	2000	1860	1770	....
Finish	4*D*	106	163	186	262
"	6*D*	216	209	299	273
"	8*D*	264	282	359	405
"	10D	537	451	583	....
"	12*D*	498	...	637	....
Fence	8*D*	690	686	709	780
"	10*D*	855	912	1030	1092
Fine	3*D*	121	...	164	....

The timber of the tests of Darrow and Buchanan was well seasoned yellow pine and oak, and the average compressive strengths are given as 7000 and 10,200 lb. per sq. in. for the two sticks of yellow pine used and 5300 lb. per sq. in. for the oak.

The strength of the timber used in the tests of Morgan and Marish, white pine, yellow pine, spruce, fir, and oak, is not given, but the statement is made that the lumber was obtained from the stock piles in a local lumber yard, and that it was not thoroughly seasoned at the time the experiments were started.

At first inspection, the results of the different tests appear to differ by so great an amount that any deductions are worthless. However, when all the factors that enter into the tests are considered, the variation in the strength of the different joints can be largely explained. The ultimate strengths of the blocks of timber in the three sets of tests varied considerably. The method of measuring the slip of the joints was rough in all cases. In at least two of the series of tests, the slip of the joint was measured on one side of the joint alone. This method can never give the true values of the deformations, and erratic results are to be expected. My experience in testing timber joints has been that if measurements are made carefully, the platted load-deformation curves will be remarkably smooth. Also, in order

*Consulting engineer, Holbrook Bdg., San Francisco, formerly Chief Structural Engineer, Panama-Pacific International Exposition.

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TABLE IV—*Morgan and Marish*

STRENGTH OF WIRE NAILS AT ULTIMATE FAILURE OF JOINTS FOR WHITE PINE, YELLOW PINE, SPRUCE, FIR, AND OAK

Size of Nails	Number of Nails Tested	Length of Nails in Inches	Gauge of Wire	Average Strength in Pounds per Nail for the Total Number of Nails Tested				
				White Pine	Yellow Pine	Spruce	Fir	Oak
8*D*	20	2½	10¼	230	294	187	478	656
10*D*	20	3	9	235	324	237	475	608
12*D*	8	3¼	9	318	625	332	360	665
16*D*	20	3½	8	299	494	263	456	750
20*D*	20	4	6	372	746	386	632	992
30*D*	20	4½	5	540	1221	629	832	1392
40*D*	20	5	4	656	1067	555	837	1580
50*D*	12	5½	3	712	1425	563	985	1925
60*D*	12	6	2	826	1783	794	...	2125
BARBED WIRE NAILS								
8*D*	10	2½	10¼	...	425	...	307	...
10*D*	10	3	9	...	460	...	318	...

to obtain a curve that will express fairly accurately the relation of load to deformation, the slips of the joints must be measured closer than $\frac{1}{16}$ inch.

For purposes of comparison of the results of three sets of tests Table V has been prepared, which gives the resistance of the various sizes of nails at the elastic limit of the joints. To bring all experiments to the same basis, the values of Walker and Cross, which are for white and Norway pine, have been increased by the factor 1.45. This factor represents the ratio of the average or effective unit bearing pressures of yellow pine to white and Norway pine at the elastic limit for the case of a round metal pin bearing against the ends of the fibres in a close fitting hole in accordance with the formula developed in the preceding article. Similarly, the values of the tests of Darrow and Buchanan, which are for the ultimate strength of the joints, have been reduced by the factor 0.41, which represents the ratio of the strength of the joints at the elastic limit to that at the ultimate strength multiplied by the ratio of the average unit bearing pressures at the elastic limit for the timbers of the two tests.

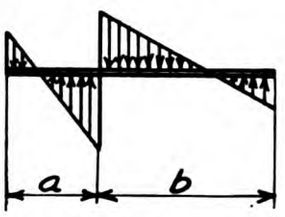

FIG. 9. FORCES ACTING ON SCREW IN JOINT.

a = thickness of side piece.
b = depth of penetration into centre piece.

The values in the fourth column were selected as the average values for a slip of joint of $\frac{1}{16}$ in., and were taken from the curves in the bulletin of the tests. In all three sets of experiments, it was found that the elastic limit of the joints corresponded to a slip of the joints of approximately $\frac{1}{16}$ inch.

A. W. Muenster, in the Journal of the Association of Engineering Societies, discussing the tests of Walker and Cross, proposed expressing the shearing resistance of a wire nail at the elastic limit of the joint by the formula Cd^2, C being a coefficient dependent on the timber, and d being the diameter of the nail. For white and Norway pine, C would be approximately 5500. Further he proposed to take the working values at about 60% of the strength at the elastic limit, or a coefficient of 3300.

W. K. Hatt, in presenting the results of the experiments of Darrow and Buchanan to the Indiana Engineering Society, recommended that the safe working values of a wire nail in yellow pine be expressed by the formula:

$S = 9.5\ D$, where D is the 'penny' weight of the nail.

Table VI gives the working values for the strength of

TABLE V

LATERAL STRENGTH OF WIRE NAILS AT ELASTIC LIMIT OF JOINT IN YELLOW PINE

Nail Size of	Strength in Pounds		
	Walker and Cross	Darrow and Buchanan	Morgan and Marish
8*D*	128	148	120
10*D*	163	296	175
12*D*	...	...	250
16*D*	163	350	260
20*D*	316	382	375
30*D*	328	...	540
40*D*	400	595	480
50*D*	495	...	630
60*D*	525	764	775
80*D*	725	...	...

TABLE VI

SAFE WORKING VALUES FOR THE LATERAL STRENGTH OF WIRE NAILS IN YELLOW PINE

Comparison of Results by Methods of Muenster and Hatt, with Modified Coefficients		
Size of Nail	$S - 4000\ d^2$	$S - 8D$
6*D*	53 lb.	48 lb.
8*D*	62 "	64 "
10*D*	88 "	80 "
12*D*	88 "	96 "
16*D*	110 "	128 "
20*D*	165 "	160 "
30*D*	194 "	240 "
40*D*	226 "	320 "
50*D*	268 "	400 "
60*D*	322 "	480 "
80*D*	364 "	640 "

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wire nails, (1) by Muenster's rule, but using a coefficient, $C = 4000$, and (2) by the rules $S = 8\,D$. The value of $C = 4000$ is obtained by applying a safety factor of two to the value $C = 5500$, and multiplying the result by 1.45, as explained previously, to bring the coefficient to the basis of yellow pine.

Mr. Hatt states that the rule which he proposes should not apply to nails heavier than $20D$.

From consideration of all the tests, I recommend using for the case of nails in Douglas fir the formula $S = 4000\,d^2$, or for nails up to and including $20D$ nails the values of the third column of the preceding table, which represent $S = 8D$.

Common Wood-Screws. The strength of ordinary wood-screws in single shear was investigated as thesis work in Cornell University by Andrew Kolberk and Milton Birnbaum and discussed by them in the *Cornell Civil Engineer*, Vol. 22, No. 2, November 1913. "The screws were the ordinary cut, flat-head screws, made by the American Screw Co. of Providence, Rhode Island." The timber employed in the joints was cypress, yellow pine, and red oak. The average strength in end bearing of the three timbers was found to be 4980, 7580, and 8440 lb. per sq. in., respectively. The thickness of the timber cleats varied with the length of screw used, but the test piece was always arranged to make the screws act in single shear. It was found by experiment that screws could not be driven closer than $2\frac{1}{2}$ in. from the edge perpendicular to the direction of fibres without danger of splitting the wood. It was also often found impossible to drive the screws without previously boring holes, and in such cases the size of hole was made equal to the diameter of the screw at the root of thread. In oak, and in the case of the large screws in yellow pine, separate holes had to be bored for the shank and for the threaded portion of the screw. A hole was also bored for the head of the screw, thus bringing it flush with the surface of the wood. Every part of the screw was thus brought into action. The procedure in testing was to measure the force at each $\frac{1}{32}$-in. slip up to a maximum slip of $\frac{3}{16}$ in. As this slip is more than would be allowed in practice, it was not thought necessary to carry the tests to the ultimate capacity of the joints.

Fig. 9 shows in a general way the forces acting on a screw in a joint. The screw in such a joint was but slightly deformed in cypress, the wood being so soft as to crush readily without bending the screw. In yellow pine and oak, however, the screws were bent as shown in the figure.

Curves in which the load per screw in pounds was platted against the slip in inches showed the following results: In cypress, while a joint having a thinner side-piece might be stronger than one having a thicker side-piece during the first increments of slip, it did not continue to be stronger during the last few increments of slip. In yellow pine and oak, however, the joint with the thinner side-piece, once being the stronger, continued so during the entire test.

Investigation relative to the determination of the proper proportion of the length of screw to the thickness of side-piece, showed that in general, the joint with the

TABLE VII

LATERAL STRENGTH OF SCREWS IN YELLOW PINE AND OAK CORRESPONDING TO A SLIP OF JOINT OF $\frac{1}{32}$ INCH

Length of Screw, In.	Gauge of Screw	Thickness of Side Piece	Load in Lb. $\frac{1}{32}$-in. slip	Load in Lb. $\frac{1}{16}$-in. slip
Yellow Pine				
3	20	$1\frac{1}{2}$	758	1002
		1	924	1094
3	16	$1\frac{1}{2}$	477	657
		1	557	750
3	12	$1\frac{1}{2}$	437	585
		1	586	696
$2\frac{1}{2}$	20	$1\frac{1}{2}$	590	810
		1	770	936
		$\frac{3}{4}$	780	960
$2\frac{1}{2}$	16	$1\frac{1}{2}$	453	580
		1	563	702
		$\frac{3}{4}$	526	631
$2\frac{1}{2}$	12	$1\frac{1}{2}$	414	530
		1	520	622
		$\frac{3}{4}$	508	610
2	20	1	606	797
		$\frac{3}{4}$	632	802
2	18	1	472	643
		$\frac{3}{4}$	458	625
2	16	1	382	531
		$\frac{3}{4}$	410	601
2	12	1	322	514
		$\frac{3}{4}$	405	573
$1\frac{1}{2}$	18	1	346	432
		$\frac{3}{4}$	460	537
		$\frac{5}{8}$	451	501
$1\frac{1}{2}$	16	1	320	365
		$\frac{3}{4}$	394	504
		$\frac{5}{8}$	417	509
$1\frac{1}{2}$	12	1	317	360
		$\frac{3}{4}$	394	473
		$\frac{5}{8}$	404	488
Red Oak				
3	24	$1\frac{1}{2}$	707	1144
		1	933	1308
3	16	$1\frac{1}{2}$	543	754
		1	710	932
$2\frac{1}{2}$	24	$1\frac{1}{2}$	580	842
		1	750	1154
$2\frac{1}{2}$	16	$1\frac{1}{2}$	442	634
		1	557	809
		$\frac{3}{4}$	627	874
2	20	$\frac{3}{4}$	700	912
2	16	1	513	681
		$\frac{3}{4}$	600	767
2	12	1	456	639
		$\frac{3}{4}$	529	632
$1\frac{1}{2}$	18	1	514	601
		$\frac{3}{4}$	603	802
$1\frac{1}{2}$	12	1	383	416
		$\frac{3}{4}$	523	590

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thin side-piece was the strongest. A $\frac{3}{4}$-in. side-piece and $2\frac{1}{2}$-in. screw gives a ratio of 0.3 between side-piece and screw; a 1-in. side-piece and $2\frac{1}{2}$-in. screw has a ratio of 0.4. For a 2-in. screw, the $\frac{3}{4}$-in. side-piece gave the strongest joint, especially with the screws of the smaller gauges. This is a proportion of 0.375. For the $1\frac{1}{2}$-in. screw, the strongest joint was that with a side-piece $\frac{5}{8}$-in. thick, or a proportion of 0.4. Thus it would seem that a side piece of about 0.4 of the length of the screw will give the strongest joint. Or, conversely, to obtain the strongest joint, the screws should have a length of approximately $2\frac{1}{2}$ times the thickness of side-pieces. In the joints with yellow pine and oak timber, it was found that the strength of the joint varied as the square root of the penetration of the screws into the centre timber, while for the cypress joints the proportion varied as the cube root of the penetration into the centre timber.

Table VII gives the strength of the screws at a slip of joint of $\frac{1}{32}$ and $\frac{1}{16}$ in. for the joints framed with yellow pine and oak. This table has been condensed from the results published in the *Cornell Civil Engineer*, the values for slips above $\frac{1}{16}$ in. being omitted for the reason that this slip has been found to represent the elastic limit in the case of nailed joints, and the table may thus be compared with those of the nailed joints.

"In the case of yellow pine it was found that the strength of the joint varied with its weight, or specific gravity. The heavier joints invariably gave the larger results. In order to reduce all the values to a common standard, the weight of a joint of average specific gravity was computed for each size of side-piece. The results were compared with each other and corresponding differences in strength and weight noted. From the averages of these values the mean difference in weight of joint was found. Joints were reduced in this manner to the strength corresponding to the weight of a joint of average specific gravity. A difference of 0.1 lb. in the weight of a joint was found to make a difference of 10 lb. at the $\frac{1}{32}$-in. slip and 30 lb. at the $\frac{3}{16}$-in. slip.

Table VIII gives the average lateral resistance per screw for the yellow pine and oak joints at the assumed elastic limit or for a slip of joint of $\frac{1}{16}$ in. The table also shows the relation of these loads to values obtained by multiplying the square of the diameter of the screw by an arbitrary factor of 8750, and also shows the relation of the loads to the values obtained by multiplying the gauge of the screw by an arbitrary factor of 45. With the exception of the No. 18 gauge screws, the table shows that the arbitrary formula, $S = 8750\ d^2$, where S = the resistance of the screw at a slip of joint of $\frac{1}{16}$ in., and d = the diameter of the screw,

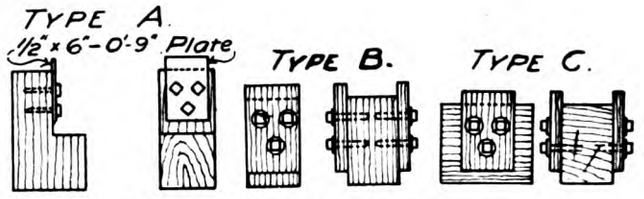

FIG. 10. TYPES OF LAG-SCREWED JOINTS.

Type *A* is an 8 by 10-in. or 12-in. timber, 1 ft. $5\frac{1}{2}$ in. long.

Type *B* is composed of two $1\frac{1}{4}$ to 2 in. by 8 in. pieces, 1 ft. 1 in. long, and an 8 by 8-in. timber, 1 ft. 1 in. long.

Type *C* is composed of two $1\frac{3}{8}$ to 2 in. by 8-in. pieces, 1 ft. long, and an 8 by 12-in. timber, 1 ft. 2 in. long.

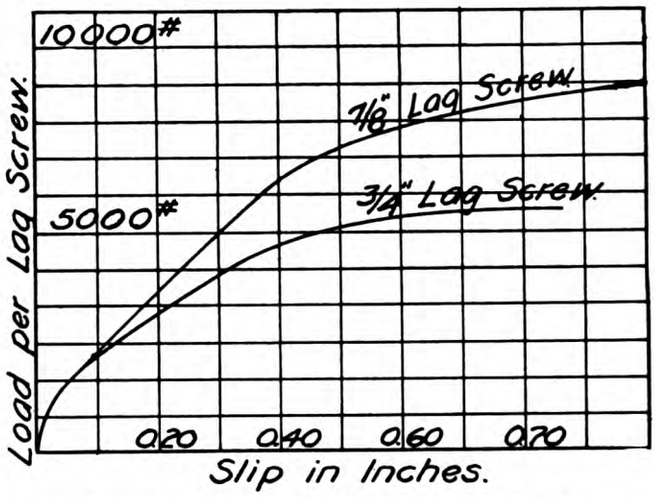

FIG. 11. LOAD CURVES FOR LAG-SCREWED JOINTS WITH STEEL PLATES. CURVES SHOW AVERAGE FOR ONE LAG SCREW.

holds fairly well, and may be adopted for determining working loads. The difference between the actual resistances as shown for yellow pine and oak is small, and in conformity with the relative properties of the two timbers.

For determining the diameters of the screws, the standard rule

$$d = 0.0578 + 0.01316\ G$$

was used, where d = the diameter of the screw, and G = the gauge of the screw.

The working loads for Douglas fir may be taken as shown in Table IX, whose values have been computed from the formula

$$S = 4375\ d^2$$

TABLE VIII

AVERAGE LATERAL RESISTANCE OF SCREWS AT A SLIP OF JOINT OF $\frac{1}{32}$ AND $\frac{1}{16}$ IN. FOR YELLOW PINE AND OAK.

Gauge of Screw	Diameter of Screw		Average Load Corresponding to a Given Slip of Joint of $\frac{1}{32}$ in.-Lb.				Value for	Value for
			Yellow Pine		Oak			
	d	d^2	$\frac{1}{32}$-in. Slip	$\frac{1}{16}$-in. Slip	$\frac{1}{32}$-in. Slip	$\frac{1}{16}$-in. Slip	$S=8750d^2$	$S=45G$
12	0.2157	0.0464	430	545	475	570	406	540
16	0.2684	0.0720	467	583	570	780	630	720
18	0.2947	0.0868	460	550	558	701	760	810
20	0.3210	0.1030	723	915	700	912	900	900
24	0.3738	0.1398	...	...	700	1112	1220	1080

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TABLE IX

SAFE LATERAL RESISTANCE OF COMMON WOOD-SCREWS WITH DOUGLAS FIR

Gauge of Screw	Safe Lateral Resistance	Gauge of Screw	Safe Lateral Resistance
12	205 lb.	20	450 "
14	256 "	22	529 "
16	315 "	24	615 "
18	380 "		

Lateral Resistance of Lag Screws. The action of a lag screw when subjected to lateral shear and flexure is similar to that of a nail, but more like that of a common wood-screw. Since the diameter of a lag screw in proportion to its length is considerably greater than that of a nail, the bending is less marked, and the resistance is dependent almost wholly upon the bearing strength of the timber.

The only data on the resistance of lag screws is given in Kidder's 'Architects and Builders Pocket Book,' and in Thayer's 'Structural Design.' In the latter volume, the lag screw is treated as if it were a bolt, when computing its resistance. Kidder shows a detail of the end joint of a scissors truss, in which a thin steel plate is lagged to the truss chord. When used in this manner with Douglas fir the value of a $\frac{3}{4}$ by $4\frac{1}{2}$-in. lag screw with a steel plate of $\frac{5}{16}$ in. minimum thickness is given at 2100 lb., similarly, the value of a $\frac{7}{8}$ by 5 in. lag screw is given at 2800 lb. There is no statement made as to the basis on which these values are selected. Thayer's figures for the same conditions are 1125 lb. and 1575 lb., respectively.

In an article, already mentioned,[1] I published the results of some tests on lag-screwed joints made at the University of California in 1913. In these tests, $\frac{3}{4}$ by $4\frac{1}{2}$ in. lag screws were used to fasten 2 in. planking to 12 in. blocks of timber, with the screws bearing against the fibres of the planking, and across the fibres of the blocks. The results are given in Table X. The test joints were made by lagging two 2 by 8-in. planks to the sides of a 12 by 12-in. timber block.

[1] *Engineering News*, Vol. 71, No. 13.

TABLE X

1913 TESTS OF LAG-SCREWED JOINTS

Joint	First Slip Total Load, Lb.	First Slip Load per Screw, Lb.	Ultimate Load Total Lb.	Ultimate Load Per Screw, Lb.
a (6 screws)	11,000	1,833	23,000	3,833
b (6 screws)	16,000	2,667	30,000	5,000
c (8 screws)	21,000	2,625	30,000	3,750
d (6 screws)	16,000	2,667	31,000	5,167
e (8 screws)	20,000	2,500	30,000	3,750
f (8 screws)	18,000	2,250	29,000	3,625
Average value of one screw		2,423		4,187

The failure in joints *a*, *c*, *e*, and *f* was due to the screws splitting the side of the main timber. In joints *b* and *d*, the attached piece was sheared by the screws.

No detail measurement of slip was made, but it was noted that the first large movement appreciable to the eye occurred at a load of approximately 2400 lb., and was between $\frac{1}{16}$ and $\frac{1}{8}$ inch.

More recently, I made a series of tests on lag-screwed and bolted joints at the Panama-Pacific International Exposition, through the courtesy of the Tinius Olsen Testing Machine Co. of Philadelphia. These tests have been described in a recent article.[2] In these tests, careful measurements of the slips of the joints were made, corresponding to constant increments of load, in addition to making autographic records of the load-deformation curves through the medium of the autograph attachment on the machine.

The lag-screwed joints consisted of four joints in which a $\frac{1}{2}$-in. steel plate was fastened to a timber block, and ten joints in which wooden plates varying from $1\frac{1}{4}$ to 2 in. thick were lagged to 8 by 8-in. and 8 by 12-in. blocks. The detail makeup of these joints is shown in Fig. 10, *a*, *b*, and *c*. Fig. 11 shows the curves for the joints with steel plates, while Fig. 12 shows the typical curves for the all-timber joints. The results of the tests are given in Table XI.

[2] *Engineering News*, July 20, 1916.

TABLE XI

1915 TESTS OF LAG-SCREWED JOINTS

Type	Number and and Size of Lag Screws	Thickness of Side Pieces	Thickness of Centre Pieces	Load at Apparent Yield Point, Lb.	Load at Slip of $\frac{1}{16}$ in., Lb.	Final Load, Lb.	Final Slip, In.	Remarks
A	Three $\frac{3}{4}$-in.	$\frac{1}{2}$-in. steel plate		6,500	7,700	20,000	0.92	Autograph record
A	Three $\frac{3}{4}$-in.	$\frac{1}{2}$-in. steel plate		5,500	6,700	19,700	0.75	
A	Three $\frac{7}{8}$-in.	$\frac{1}{2}$-in. steel plate		5,000	6,700	30,000	1.14	
A	Three $\frac{7}{8}$-in.	$\frac{1}{2}$-in. steel plate		8,000	7,500	30,000	1.15	
B	Six $\frac{7}{8}$-in.	2-in.	8-in.	29,000	12,500	49,100	1.40	Ultimate load
B	Six $\frac{7}{8}$-in.	2-in.	8-in.	22,000	13,800	44,700	1.44	Ultimate load
B	Six $\frac{7}{8}$-in.	2-in.	8-in.	25,000	10,700	44,400	1.69	
B	Six $\frac{3}{4}$-in.	$1\frac{3}{8}$-in.	8-in.	16,000	9,400	28,885	1.30	
B	Six $\frac{3}{4}$-in.	$1\frac{1}{2}$-in.	8-in.	21,000	12,000	33,400	1.14	
B	Six $\frac{3}{4}$-in.	$1\frac{1}{4}$-in.	8-in.	20,000	12,400	34,000	1.49	Ultimate load
C	Six $\frac{7}{8}$-in.	2-in.	8-in.	21,000	14,400	34,000	1.61	
C	Six $\frac{7}{8}$-in.	2-in.	8-in.	20,000	10,400	33,000	1.70	
C	Six $\frac{3}{4}$-in.	$1\frac{3}{8}$-in.	8-in.	.....	8,500	20,000	0.54	Load removed
C	Six $\frac{3}{4}$-in.	2-in.	8-in.	.....	10,500	14,000	0.13	Load removed

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Reference to Fig. 12 indicates that the working values for lag screws given by Kidder correspond to slips of joint of 0.08 in. for the $\frac{3}{4}$ by $4\frac{1}{2}$-in. screws and 0.12 in. for the $\frac{7}{8}$ by 5-in. screws.

With respect to the safe working values to be adopted, there may be some difference of opinion. In the case of the joints with steel plates, the first break in the load-slip curve occurs at a total load on the joint of about 6000 lb. With the all-timber joints, there is also a slight break in the curves at about 8000 lb., but a marked break at a total load on the joint of approximately 23,000 lb. for the $\frac{7}{8}$-in. screws and 18,000 lb. for the $\frac{3}{4}$-in. screws. It was found for the steel-plate joints that when the load was removed at about 8000 lb. the joint did not fully recover its slip, although the remaining set was probably due to the initial adjustment of the joint.

In conformity with the tests on nailed joints, it is recommended that the working values for lag screws be taken at one-half the loads producing a slip of $\frac{1}{16}$ in. The safe lateral resistances would then be as follows:

	Lb. per Screw
Metal plate lagged to timber, $\frac{3}{4}$ by $4\frac{1}{2}$-in. lag screw	1030
Metal plate lagged to timber, $\frac{7}{8}$ by 5-in. lag screw	1200
Timber planking lagged to timber, $\frac{3}{4}$ by $4\frac{1}{2}$-in. lag screw	900
Timber planking lagged to timber, $\frac{7}{8}$ by 5-in. lag screw	1050

There appeared to be no reduction in stiffness for those joints in which the lag screws bore across the fibres of the timber in the centre block during the first portion of the tests.

In the Proceedings of the American Railway and Maintenance of Way Association, Vol. 10, 1909, there is published a method for determining the safe lateral resistance of a track spike. The discussion is also given in Jacoby's 'Structural Details.' Referring to Fig. 13

$$P = \frac{pbL^2}{4L + 6e} \text{ where}$$

P = safe lateral resistance of the spike.

p = maximum safe unit bearing stress of the timber on the spike.

b = diameter or side of the spike.

L and e, as shown in the figure.

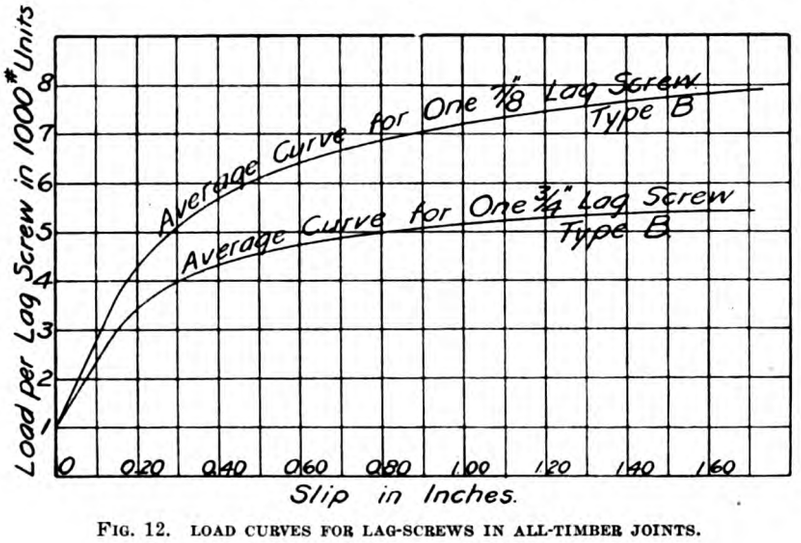

FIG. 12. LOAD CURVES FOR LAG-SCREWS IN ALL-TIMBER JOINTS.

Applying this formula to the joints of the tests having a steel plate lagged to the timber, assuming the diameter of the lag screw to be constant throughout its length and equal to its nominal diameter and using a limiting bearing-stress of 1300 lb. per sq. in. on the timber, there is found for the case of the $\frac{3}{4}$-in. lag screws with a $\frac{1}{2}$-in. plate, a safe lateral resistance of 770 lb. per lag screw. Similarly for a $\frac{7}{8}$ by 5-in. lag screw, the safe lateral resistance is found to be 1040 lb. The maximum flexural stress in the lag screw is 10,770 lb. per sq. in. for the $\frac{3}{4}$-in. lag screw and 13,400 lb. per sq. in. for the $\frac{7}{8}$-in. lag screw. These values do not differ greatly from those of the tests.

In Table XII, the recommended values of Kidder, Thayer, the values as derived from the formula just given and those recommended by this article are given.

TABLE XII

COMPARISON OF SAFE LATERAL RESISTANCE OF LAG SCREWS WHEN USED TO FASTEN A METAL PLATE TO TIMBER AS GIVEN BY VARIOUS AUTHORITIES.

Authority	$\frac{3}{4}$ by $4\frac{1}{2}$-in. Lag Screw, Lb.	$\frac{7}{8}$ by 5-in. Lag Screw, Lb.
Kidder	2100	2800
Thayer	1125	1575
Theoretical formula	770	1040
Tests in present article	1030	1200

Lateral Resistance of Bolts. The values for the strength of bolted joints as computed by the methods and formulae given by the various text and hand books differ widely. Probably in no other instance in structural engineering is there a greater discrepancy between the results of the methods of design of the various authorities than in the case of the design of a bolted joint. Again, although this connection is one used constantly in ordinary construction, both temporary and permanent, apparently no tests have ever been made on the actual strength of bolted timber-joints from which working values might be selected with the assurance of reasonable accuracy. In fact, the only tests which are on record, as far as I have been able to determine, are those of E. E. Adams, first published in the California Journal of Technology of the University of California in 1904, and later discussed by me.[3]

The present discussion will review the common methods of designing bolted joints, and compare the results with those of the tests on 24 bolted joints which I made in 1915 in conjunction with

[3] *Engineering News*, Vol. 71, No. 13. Since writing this article, I am informed that Harold A. Thomas of Rose Polytechnic, Terre Haute, Indiana, has made a series of tests on bolted timber joints which are to be published in *Engineering News*. These tests were apparently made for the purpose of furnishing material for Howe's proposed revision of the subject in Kidder's 'Pocket Book.'

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the tests on lag-screwed joints previously described. For a detailed description of these tests, the reader is referred to *Engineering News* for July 20, 1916.

Current Methods of Design. Fig. 14 represents a splice in the tension chord of a truss. The thickness of

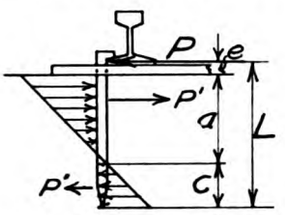

FIG. 13. DIAGRAM OF STRESS ON TRACK-SPIKE.

the chord is $2L$, while the thickness of either splice is L. The total stress in the chord is P, of which it is assumed that each splice-pad takes half.

Kidder in his 'Architects and Builders Pocket Book' states with regard to the design of bolted timber-joints, "When the pieces joined together are not more than two inches thick, so that they can be tightly drawn together, thereby producing a good deal of resistance from friction, the bolts may be considered as rivets, and proportioned for shearing and bearing only, the bending moment being neglected. When the pieces of wood are more than two inches thick, the bolts should be proportioned for shearing, bearing, and flexure." Where bending is considered, Kidder recommends that the bending moment, M, be taken as $1/12$ P times the distance between the centres of the splice pads. In Fig. 15, M would

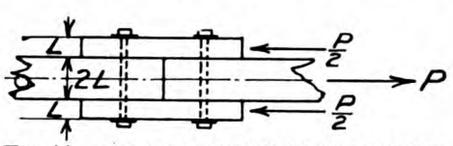

FIG. 14. SPLICE IN TENSION CHORD OF TRUSS.

then be equal to 1/12 P times $3L$ or $\frac{1}{4}$ PL. H. S. Jacoby in his 'Structural Details' shows the bending moment to be equal to $\frac{1}{2}$ PL when the pressure against the bolt is considered to be uniform over its entire length. M. A. Howe in 'A Treatise on Wood Trusses' uses the same formula as Jacoby, or $M = \frac{1}{2}$ PL. W. J. Douglas in Merriman's 'American Civil Engineers Handbook' disregards the bending in bolts, where the pieces joined are less than three inches thick, otherwise the bolt is considered as a restrained beam, and computed as recommended by Kidder. The working stress used for bending in the bolts in the preceding formulae is 22,500 lb. per sq. in. Horace R. Thayer[4] in 'Structural Design,' Vol. 1, recognizes the necessity of a method of computation for bolt sizes more consistent with practice. He recommends that the pressure on the bolt be considered as concentrated on the portions of the bolt immediately adjacent to the contact faces of the timbers; the pressure to be considered uniform over the length on which it exists. This length a is to be such, that the resultant bending in the bolt will just equal the flexural or shearing strength of the bolt.

Thus referring to Fig. 15, which shows the assumed distribution of load on the bolt, where

S = maximum allowable flexural unit stress in bolt.

B = allowable unit bearing stress against ends of fibres of timbers.

d = diameter of bolt.

Assuming that the shear on the bolt need not be considered, and that the bending on the bolt alone need be considered, $a = d\left(\frac{\pi S}{32B}\right)^{\frac{1}{2}}$

For Douglas fir with iron bolts, Mr. Thayer uses $S = 12{,}000$ lb. per sq. in., and $B = 1250$ lb. per sq. in.

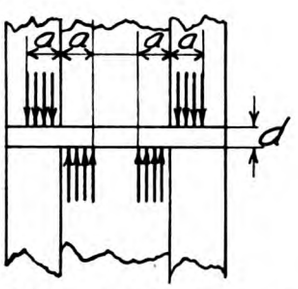

FIG. 15. DIAGRAM OF STRESS ON BOLT.

For steel bolts, S is increased to 16,000 lb. per square inch.

In Table No. XIII is shown the working strength of such joints, as determined by the methods of Jacoby, Howe, Kidder, Merriman, and Thayer, as well as from curves taken from actual tests and from a formula derived by myself. In the case of all these authorities, the lowest and highest values are shown; namely, the values for joints with 2 in. and $2\frac{7}{8}$-in. splice-pads and those with 6-in. splice-pads. This table emphasizes the wide variation in the prescribed practice of designing bolts.

There is this radical difference between Thayer's method and the others quoted, namely, using Thayer's analysis the value of L in the joint may be in excess of a without decreasing the strength of the joint. In other words, the joints with a 12-in. centre timber and 6-in. side-timbers will have the same strength as the joints with side-timbers of a width equal to the distance a.

Description of Tests of Bolted Joints. As noted previously, the 1915 series of tests embraced twenty-four bolted joints, the bolts varying in size from $\frac{5}{8}$ to 1 in. diam. Fig. 16a and b shows the details of all the joints tested. The tests were compressive tests. The washers were standard cut-steel pressed washers throughout. Before commencing the tests, all nuts were loosened so that friction would not affect the results. This was to approximate the condition of a joint after shrinkage has taken place. Careful measurements were made of the slip of the joints, in addition to recording the load-deformation curves by means of the autographic attachment of the testing machine.

Table XIV gives a summary of the results of the tests. A careful study of the curves representing the relation

[4]See also *Engineering News*, Vol. 71, No. 17, p. 923.

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TABLE XIII

COMPARISON OF VALUES FOR WORKING STRENGTH OF BOLTED JOINTS, DETERMINED BY VARIOUS METHODS.

Authority.	2 Inch Side Timbers. 4 Inch Centre Timbers				2⅞ Inch Side Timbers 5¾ Inch Centre Timbers.				6 Inch Side Timbers. 12 Inch Centre Timbers.			
	3-⅝ In. Bolts.	3-¾ In. Bolts.	3-⅞ In. Bolts.	3-1 In. Bolts.	3-⅝ In. Bolts.	3-¾ In. Bolts	3-⅞ In. Bolts.	3-1 In Bolts.	3-⅝ In. Bolts.	3-¾ In. Bolts.	3-⅞ In. Bolts.	3-1 In Bolts.
Merriman (a) (W. J. Douglas.)	9,000	10,800	12,600	14,400	12,937	15,675	18,112	20,200	1,080	1,860	2,960	4,410
Howe. (b)	1,793	3,100	4,920	7,350	1,248	2,160	3,420	5,110	598	1,030	1,640	2,450
Kidder. (c)	10,125	12,144	14,196	16,200	2,590	4,460	7,100	10,600	1,080	1,860	2,960	4,410
Thayer. (d)	3,330	4,800	6,540	8,850	3,330	4,800	6,340	8,850	3,330	4,800	6,540	8,850
Jacoby. (e)	1,620	2,740	4,400	6,615	1,295	2,230	3,555	5,300	540	930	1,480	2,205
Test Curves. (f)	4,250	5,000			4,250	5,000			4,250	5,000	6,750	9,500
Test Curves. (g.)	5,500	6,500			5,500	6,500			5,500	6,500	9,000	12,500
Dewell Formula.	(h) 3,171	(h) 4,350	(h) 5,700	(h) 7,380	(h) 3,747	(h) 4,920	(h) 6,255	(h) 7,890	4,388	6,300	8,550	11,115

a- Bearing Pressure = 1200 lb. per Sqr. In., Stress In Bolts = 22,500 lb per Sqr. In.
b- " " 650 " " " " " " " = 25,000 " " " "
c- " " 1350 " " " " " " " = 22,500 " " " "
d- " " 1250 " " " " " " " = 16000 " " " "
e- " " 1080 " " " " " " " = 22500 " " " "
f- Values = Half Loads, when Δ = 0.0625 In.
g- " = Loads, when Δ = 0.025 In.
h- " = For M = RPl where R varies from 1/3 to 2/27

$$l = d\left(\frac{\pi S}{32 B}\right)^{\frac{1}{2}}$$

Values of l, for S = 16,000 lb. Sqr. In. B = 1,300 " " "

d.	l.	Joint Strength.
⅝ In.	3.6	4,388
¾ In.	4.3	6,289
⅞ In.	5.0	8,531
1 In.	5.7	11,115

of load to slip has led to the conclusion that for the test joints having the same number and diameter of bolts, except for those joints in which the bolts bear across the

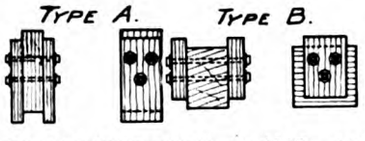

FIG. 16. DETAILS OF JOINTS TESTED IN 1915. SIZES OF TIMBERS AND BOLTS AS LISTED IN TABLE XIV.

fibres of the centre timber, the load-slip or load-deformation curve is practically a constant. In other words, for the limits of the tests, it appears that the strength of a bolted joint depends upon the number and size of the bolts, and is nearly independent of the thickness of the timbers forming the joint. Fig. 17 shows the curves representing the relation between slips and loads for each set of joints having bolts of the same diameter. These curves are drawn as an average of the curves of the individual tests.

For those joints where the bolts have bearing across the fibres of the centre timber, the load-slip curves appear to coincide with those of the end-bearing joints up to a total load of approximately 30,000 lb., or up to loads of 5000 lb. per bolt. For working loads therefore, the resistance of these joints is apparently as great as those having all end-bearing. Fig. 18 shows a photograph of some of the joints which were cut open after testing.

From a study of the condition of the bolts after testing, the following theory of the distribution of loads on the bolts, and their consequent bending is proposed. Let

S = maximum allowable flexural unit-stress in the bolt.

B = maximum allowable unit bearing-stress against the ends of fibres of timber.

t = width of splice-pad.

a, b, B^1, P, P_2 as shown = one-half width of main timber.

It will be assumed that the distribution of load on the

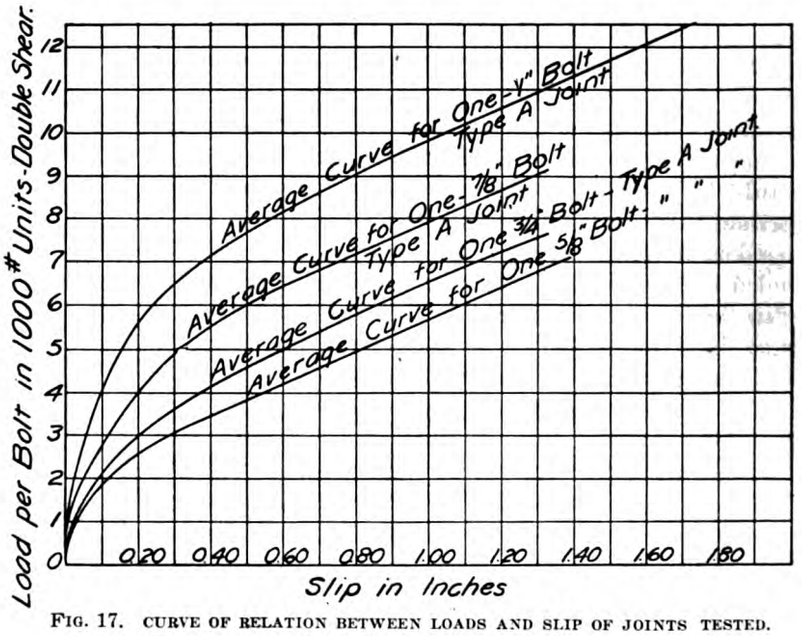

FIG. 17. CURVE OF RELATION BETWEEN LOADS AND SLIP OF JOINTS TESTED.

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TABLE XIV

1915 TESTS OF BOLTED JOINTS

Joint Type	Number and and Size of Bolts	Thickness of Side Pieces	Thickness of Centre Pieces	Load at Apparent Yield Point, Lb.	Load at Slip of $\frac{1}{16}$ in., Lb.	Final Load, Lb.	Final Slip, In.	Remarks
A	Three $\frac{3}{4}$-in.	2-in.	4-in.	.....	*	42,000†	...	
A	Three $\frac{5}{8}$-in.	2-in.	4-in.	16,000	6,500	41,000	1.85	
A	Three $\frac{3}{4}$-in.	2-in.	4-in.	12,500	7,000	45,000	1.95	
A	Three $\frac{3}{4}$-in.	2$\frac{3}{4}$-in.	5$\frac{3}{4}$-in.	11,000	8,000	45,000	1.15	
A	Three $\frac{5}{8}$-in.	2-in.	4-in.	13,000	5,000	43,500	1.68	
A	Three $\frac{3}{4}$-in.	2$\frac{3}{4}$-in.	6-in.	10,000	6,500	36,250	0.64	
A	Three $\frac{3}{4}$-in.	4-in.	8-in.	15,000	6,000	55,000	1.39	
A	Three $\frac{5}{8}$-in.	3$\frac{3}{4}$-in.	8-in.	13,000	6,500	27,000	0.72	
A	Three $\frac{5}{8}$-in.	3$\frac{3}{4}$-in.	8-in.	13,000	6,500	20,000	0.47	
A	Three $\frac{3}{4}$-in.	3$\frac{3}{4}$-in.	8-in.	15,000	4,000	28,000	0.58‡	
A	Three $\frac{3}{4}$-in.	6-in.	12-in.	13,000	7,000	60,000	1.64	
A	Three $\frac{5}{8}$-in.	6-in.	12-in.	14,000	7,500	30,000	0.83	
A	Three $\frac{5}{8}$-in.	6-in.	12-in.	15,000	9,500	46,000	1.64	
A	Three $\frac{7}{8}$-in.	6-in.	12-in.	18,000	3,500	63,000	1.78‡	
A	Three 1-in.	6-in.	12-in.	26,000	20,000	70,000	1.53	
A	Three 1-in.	6-in.	12-in.	27,000	16,500	75,000	1.78	
A	Three $\frac{3}{4}$-in.	6-in.	12-in.	16,000	10,500	45,000	1.28	
A	Three $\frac{7}{8}$-in.	6-in.	12-in.	23,000	2,000	60,000	1.46‡	
A	Three $\frac{7}{8}$-in.	5$\frac{3}{4}$-in.	12-in.	22,000	12,500	60,000	1.54	
A	Three $\frac{7}{8}$-in.	5$\frac{3}{4}$-in.	12-in.	21,000	13,500	60,000	1.26	
B	Three $\frac{3}{4}$-in.	2$\frac{3}{4}$-in.	6-in.	11,000	7,500	35,000	0.73	Ultimate
B	Three $\frac{3}{4}$-in.	4-in.	8-in.	14,000	10,500	23,000	0.53	
B	Three $\frac{3}{4}$-in.	4-in.	8-in.	15,000	10,500	29,000	0.52	Ultimate
B	Three $\frac{3}{4}$-in.	2$\frac{3}{4}$-in.	6-in.	15,000	8,000	34,000	0.63	Ultimate

NOTES.

*No slips except final slip made on this joint.

†The final loads are not necessarily the ultimate loads, as no effort was made to find the ultimate load.

‡These joints had a large initial slip which was probably due to a loose fit of the bolts in the holes.

The average slip of the joints under the heading "Load at Apparent Yield Point" was 0.12 in. Using the formula devel oped in the text, the flexural unit-stress in the bolts for this load is approximately 35,000 lb. per square inch, which is not tn excessive value for the elastic limit in flexure of the bolt.

bolt is as shown in Fig. 19, namely, triangular in shape, concentrated near the contact surfaces and of such arrangement as to produce the condition of a restrained

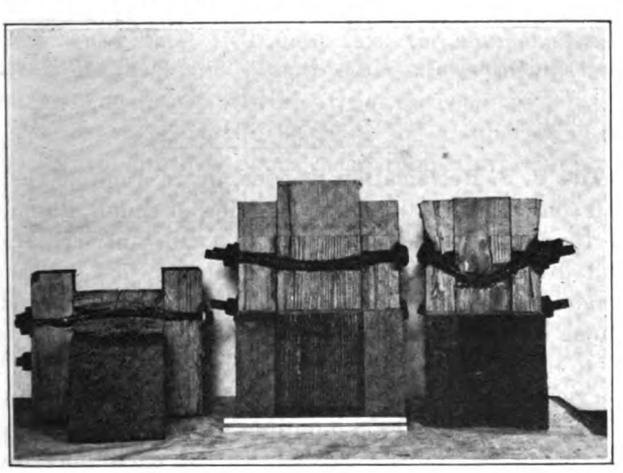

FIG. 18. PHOTOGRAPH OF JOINTS AFTER TESTING.

beam with some point of contraflexure at each contact surface.

In order to conform to these conditions b must equal $2a$. Then $B^1 = \frac{1}{2} B$.

The distribution of bending moment will be as shown, there being two equal maximum moments of amount,

$M = 2/27\ Pl.$ where $l = a + b$ and must be less or equal to t.

Under the assumption that beyond a certain minimum value of t, or width of side piece, the strength of the joint is independent of the length of bolt required, the length l may be found, such that the moment resulting

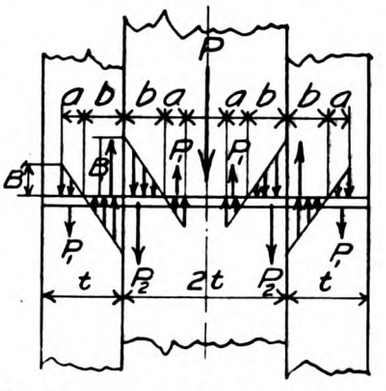

FIG. 19. ASSUMED DISTRIBUTION OF LOAD ON BOLT.

from the load on this length of bolt will just equal the flexural strength of the bolt. This method is similar to that of Thayer, the difference being in the assumed distribution of load, the resulting moment and the computed strength of bolt.

The maximum moment will occur at a point of zero

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shear, or at a point distant $\frac{1}{2}\ b = a$ either side of the contact face.

Let the moment be computed at point X

$$M = P_1\left(\frac{l}{3} + \frac{2}{9}l - \frac{1}{9}l\right) = \frac{4}{9}P_1 l$$

$$P_1 = \frac{1}{2}\left(\frac{B}{2} \times \frac{l}{3}\right)d = \frac{Bld}{12}$$

$$M = \frac{4}{9} \times \frac{Bld}{12} \times l = \frac{1}{27}dBl^2 = \frac{\pi d^3 S}{32}$$

$$l^2 = \frac{\pi d^3 S.27}{32Bd}$$

$$l = d\left(\frac{\pi S.27}{32B}\right)^{\frac{1}{2}}$$

With the safe stresses for flexure of bolts and bearing for the timber, the strength of the bolts is easily determined; and for all thicknesses of side pieces in excess of the limiting value l, the strength will be constant. For thicknesses of side pieces under l, the safe strength of the joint would be a question of bearing of the bolts against the timber, if the pressure distribution be assumed to remain constant, resulting in a decrease in the strength of the joint. The results of the tests do not bear out this assumption. It is believed that in joints where the thickness of side timbers is less than the limiting value l, the pressure-distribution diagram, while holding to the general triangular shape, changes in its relative dimensions a and b, within the limits, where $a = O$ and $a = \frac{1}{3}\ t$. Further, it is held that the ratio of a to t is always such, that the resulting bending moment on the bolt bears the same relation to the capacity of the bolt in bending as the maximum intensity of pressure on the timber bears to the resistance of the timber in bearing.

Following out these assumptions, the strength of the test joints with 2-in., $2\frac{1}{8}$-in., and 6-in. side timbers have been calculated, using 16,000 lb. per sq. in. as the flexural stress in the bolts, and 1300 lb. per sq. in. as the limiting unit-bearing pressure on the timber. The results are entered in the bottom line of Table XIII, and are seen to coincide approximately with the values taken from the test curves.

From the results of the studies on bolted joints, the safe working loads for bolts in double shear, having all end bearing, may be taken as shown in Table XIII. For bolts having side bearing on the timber the safe loads may be taken as two-thirds the values of the table. While the tests did not consider bolts in single shear alone, working loads for this condition may be taken at one-half the values of the table.

The prevailing high freight rates have resulted in the use of tugs for towing sailing ships on long voyages, the saving of time being sufficient to warrant the extra expense. The tug *Hercules* recently towed the bark *British Yeoman* from San Francisco to Balboa, the voyage taking $18\frac{1}{2}$ days. The captain of the *Hercules* stated that he expected soon to tow a vessel from San Francisco to New York by way of the Canal. A saving of a week or ten days could be made on such a trip as against dependence on sails alone.

USE OF CONCRETE FOR TREATING 'SOFT SPOTS' IN RAILWAY ROAD-BED

Concrete is being used on the Queen & Crescent railroad to eliminate 'soft spots' in the road-bed where drainage would be impracticable or unusually expensive, according to *Engineering News*. The method was introduced by M. J. Connerton, roadmaster, under the supervision of chief engineer Curtis Dougherty. Bridge ties and mud-sills are placed under the track, taking the weight of the track and trains off the road-bed directly underneath the rails. The ballast is then shoveled away and a 3 by 3-ft. trench with its centre at the outer edge of the base of rail is excavated under each rail. Concrete is then mixed and placed in the trenches to a depth of 2 ft. Six $\frac{7}{8}$-in. reinforcing rods are used, three near the bottom and three near the top of the concrete. About 1 ft. of ballast is placed over the concrete bringing it to the bottom of the tie. 'Slow' signals are displayed for the trains for about two weeks, giving time for the concrete to set. At the end of that time, the bridge-ties and mud-sills are removed and the track is re-surfaced. In a few days trains can be allowed to proceed at full speed and there is no further interruption to traffic.

This method has been used at about 25 places, varying in length from 15 to 60 ft. In none of these has the concrete shown signs of failure. At one particularly troublesome place the concrete was applied about two years ago. Since that time the track has needed to be tamped only once. This method was used at one place 40 ft. long where the estimated cost of draining satisfactorily was $180. The cost of concreting was as follows:

1 foreman, $1\frac{1}{4}$ days at $62.50 per month	$ 2.60	
10 laborers, $1\frac{1}{4}$ days at $1.45	18.12	$20.72
Cement	15.19	
Gravel	4.50	
Steel reinforcement	15.60	35.29
Total		$56.01

The U. S. Reclamation Service, up to June 30, 1915, had constructed 100 dams, 9683 miles of canals, 25 miles of tunnels, 91 miles of levees, 300 miles of irrigation and drainage pipe, 86 miles of flumes, 784 miles of wagon road, 82 miles of railroad, 2554 miles of telephone lines, and 429 miles of transmission lines. Concrete lining has been placed in 140 miles of canals. The Service has built 64,847 canal structures, 4622 bridges, 5714 culverts, and 1068 buildings. In the performance of this work, 115,599,284 cu. yd. of earth has been moved, 7,585,948 cu. yd. of indurated material, and 6,964,136 cu. yd. of rock. In constructing the dams, 1,992,502 cu. yd. of masonry has been placed, 9,231,109 cu. yd. of earth, and 978,474 cu. yd. of rock-fill and crib structures. Other materials handled include 1,023,398 cu. yd. riprap, 615,583 cu. yd. paving, 2,674,977 cu. yd. concrete, and 2,501,382 bbl. of cement, the latter mainly for concrete.

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Indeterminate Franchises for Street-Railway Companies

By GEORGE H. BINKLEY*

Representatives of the commercial organizations of the East Bay cities are now considering the proper terms of an indeterminate franchise for the San Francisco-Oakland Terminal Railways. Therefore it may be timely to outline some of the grants of this character which are now in force, such as the Chicago and Kansas City franchises.

To present the important features of the Chicago and Kansas City plans, they are given below in such a manner as to show how they meet the requirements of a model street-railway franchise as enumerated by an authority on franchises, who has given the subject much study.

In the preparation of a street-railway ordinance, it will be found that many points are covered by State law, or are controlled by State commissions, but it is well to set forth these conditions in conformity with the law and subject to the approval and authority of the commissions, anticipating the possibility of changes in the powers given to the State commissions. It will be noted that some of the items listed herein are now controlled by statute or by the Railroad Commission.

1. "The grant should be a monopoly covering all streets which are to be used for street-railway purposes, and should apply to the entire area as the boundaries now exist, or as they may at any future time be extended."

Under the Chicago plan, franchises were granted to different companies operating in different parts of the city, but under both plans, provision is made for extensions of car line. In Kansas City, the municipality reserves the right to permit other street-railway companies to operate cars over parts of the company's tracks.

2. "Provision should be made for a supervising authority to approve plans, hear complaints, audit accounts, certify expenditures, inspect equipment, etc."

In Chicago, the supervising body is known as the Board of Supervising Engineers. The name of one member is written into the ordinance, so that he is in reality an arbitrator selected in advance by the city and company. The other members are named by the city and the company respectively. The Kansas City ordinance names the two members of the Board of Control, one to represent the city and the other the company. Any difference between the two shall be submitted to and determined by a third person, as an arbiter, who is to be selected by the judges of the Kansas City Court of Appeals. In addition to representation on the Board of Control, the city selects five of the eleven directors of the corporation managing the affairs of the company.

3. "Control of the specific location of street railways should remain continuously in the hands of the public bodies."

The Board of Supervising Engineers in Chicago and the Board of Control in Kansas City have charge of the specific location of street railways.

4. "Every street-railway franchise should be indeterminate. If the franchise is revoked, the entire physical property shall be purchased either by the city or by another company authorized by the city to take it over and operate it."

In both Chicago and Kansas City the grants are indeterminate licenses and are revocable, with provision for purchase.

5. "The best plan is to fix the purchase price at the time of granting the franchise, making provision for the maintenance and renewal of the property and for the amortization of any element of franchise values or dead capital that may be included at the start."

In both cities, the purchase price is fixed, and provision is made for renewal and maintenance, but the Chicago plan provides for no amortization, while the Kansas City plan includes the amortization of certain intangible values amounting to practically one-third as much as the agreed physical valuation.

6. "A franchise should stipulate for a car service operated at regular and frequent intervals, for transfer stations where needed, for through routing wherever possible, for a reasonable speed requirement, and for a carrying capacity, at least outside the rush hours, equal to the number of persons desiring to ride."

The various items included under this paragraph are either specified in the ordinance or are controlled by the regulating board in each case.

7. "There should be a general clause requiring that cars be kept clean and properly ventilated, heated, and lighted."

The cars of the street railways come under the direction of the governing board in both plans.

8. "A street-railway franchise should reserve to the city the power to control the use of the street, including the distribution and re-distribution for all public and semi-public occupants."

Under the plans adopted in Chicago and Kansas City, the control of the uses of the streets occupied by street-railway tracks remains with the city and the boards regulating the street railways.

9. "A franchise should reserve to the city the right to pass upon the foundations, character of rails, gauge of tracks, motive power, paving, street widening, strengthening of bridges, building of viaducts, etc."

Both plans either specify by ordinance or reserve the right to name or approve the items included.

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10. "It is a reasonable requirement that the street railway sprinkle its tracks. The city should furnish all the water required for sprinkling without charge to the company."

Both ordinances require the street railway to sprinkle, and the water is furnished at the expense of the city.

11. "The city should retain the right to fix the standard of repairs to track and pavement."

Both Chicago and Kansas City retain the right to regulate track and paving repairs under the direction of the Board of Supervising Engineers and the Board of Control.

12. "The city should reserve the right to require any changes in construction, equipment, or operation that may from time to time be proved efficacious in curtailing noise and vibration nuisance."

In the matter of noise and vibration the regulatory boards have authority to require changes in construction, equipment, or operation, except in case where details are fixed by ordinance.

13. "Every street-railway ordinance should fix the initial rates of fare and provide for their readjustment either at stated intervals or from time to time on the basis of the company's earnings in relation to its investment."

Both the Chicago and Kansas City ordinances fix the rate of fare and permit the use of the city's share of earnings to reduce fares.

14. "A street-railway franchise should not prohibit the use of tracks by freight cars, but should subject such use to regulation by the city authorities."

The Kansas City ordinance not only does not prohibit the use of freight cars, but specifies as to their use, retaining the power to regulate the operation of all freight cars on street-railway tracks.

15. "The franchise should provide for the making of reports to the city, showing income, expenditures, assets, capitalization, and traffic."

The auditing of accounts and reports as to receipts and expenditures are provided for in both Chicago and Kansas City.

16. "The value of any unexpired franchises or any cost of obsolete equipment should be amortized from earnings within a reasonably short period."

The Chicago plan makes no arrangement for amortization of the value of unexpired franchises, but in Kansas City this is provided in the ordinance.

17. "Earnings should be devoted first to the payment of necessary operating expenses, including insurance, State taxes, and a fixed minimum proportion of earnings for maintenance, repairs, and renewals."

The Chicago plan calls for the payment of operating expenses and specifies that not less than 6% of the gross receipts be set aside for maintenance and not less than 8% for depreciation. The Kansas City plan requires, under "Disposition of Earnings," that the first use of funds shall be for operation, including not less than 16% of the gross receipts for maintenance, repairs, renewals, and depreciation.

18. "A separate fund should be set aside out of earnings to be used exclusively for the settlement of damage claims."

Damage claims are charged against operating expenses and are therefore provided for under both plans, but the Kansas City ordinance specifies that not less than 4% of the gross receipts shall be set aside for personal injuries and property-damage claims.

19. "Every street-railway franchise should fix the rate of interest to be paid out of earnings on the capital investment."

Chicago allows 5% on agreed valuation and Kansas City allows 6% on capital investment as determined.

20. "A model franchise would require the payment of a prescribed percentage on capital or a fixed contribution every year for amortization purposes before there are any surplus profits for anybody."

Under the Chicago plan there is no provision for amortization, but the Kansas City plan, before any surplus profits accrue, the sum of $6,300,000 shall be set aside from earnings and used for extensions and betterments without any increase in capital value. This is, as stated before, to amortize certain intangible values, but there is no provision for the amortization of the entire physical property.

Having compared the elements of these two ordinances with what has been suggested as a model street-railway franchise, it is seen that both meet most of the requirements, but that the Kansas City ordinance is an improvement on the Chicago plan in that provision is made for the amortization of certain intangible values.

PRESENT CONDITION OF LINCOLN HIGHWAY.

The following notes are taken from a recent bulletin of the Lincoln Highway Association. The highway across New Jersey and Pennsylvania is practically all paved with macadam and maintained in good condition. In Ohio, brick is the prevailing pavement, but there are still a few miles of dirt road. Much of the highway in Indiana is paved with concrete. Across Illinois macadam interspersed with gravel and earth road is the rule. In Iowa the roads are almost entirely of earth, but they are well-maintained and are in good condition except during wet weather. Conditions are similar in Nebraska. Most of the highway in Wyoming is of gravel. In Utah and Nevada, except in the vicinity of the larger towns, there has been little work. On account of the small population, outside assistance is necessary in these States if the highway is to be improved. The association is now endeavoring to raise $50,000 for the improvement of the highway between Ely and Reno. The highway in California is in excellent condition and is nearly all of it paved with concrete.

Water-power of the world is estimated at 700,000,000 horse-power; 21% in Africa, 21% in North America, 14% in South America, 32% in Asia, 2% in Australia, and 10% in Europe.

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Graphical Analysis of Continuous Beams by the Use of the Principle of Continuity

By CYRIL PROVO HUBERT*

The following analysis is general, being applicable to continuous beams having any number of equal or unequal spans.

The first step that it requires, is to divide each span into three equal parts, erecting verticals at the division points (Fig. 1) then proceed to divide into half the distance between each pair of verticals over the inner supports by means of another vertical line, establishing the effective one-third span distances in a reverse or contrary order. It remains then to ascertain the position of the fixed or inflection points of each span, which must not be misconstrued for the points of contraflexure. In order to do this by the graphical process, it is only necessary in the beginning to assume any convenient direction of the arbitrary line (1) from the point a. Where this line cuts the vertical V_2 at b, is the starting point of line (2), a straight line drawn from the point b through V_3 as shown, intersecting V_4 at c. Join the points c and d by line (3), then the left-hand inflection point L_2 of span L_2 is where line (3) cuts the datum or horizontal base line ah.

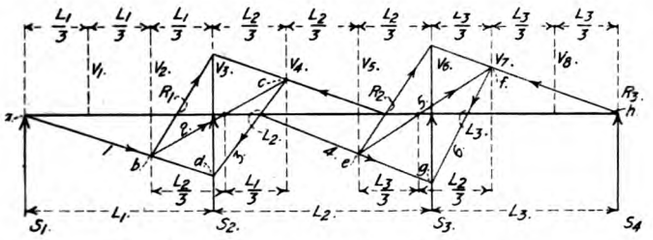
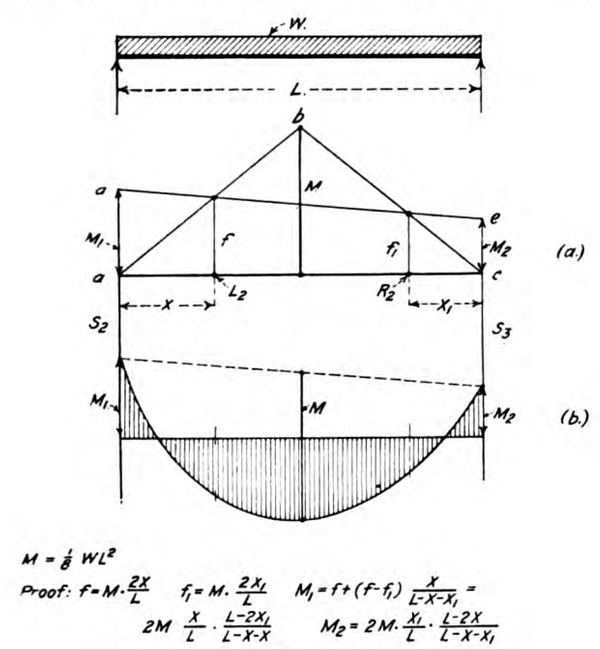


FIG. 1. GENERAL STRESS-DIAGRAM.

To locate the inflection point L_3 for span L_3, start again, from the inflection point L_2 just found, and draw an arbitrary line (4), proceeding as before.

The inflection points R_1 and R_2 are obtained in the same manner, except that it becomes necessary to start from the point h, advancing to a. It is clear, therefore, that the designations regarding the inflection points are essentially the same for either L or R inflection points, requiring no further detailed explanation. A brief demonstration of the various steps to be taken in determining the bending moments for an individual span carrying a uniform or concentrated load, will be given.

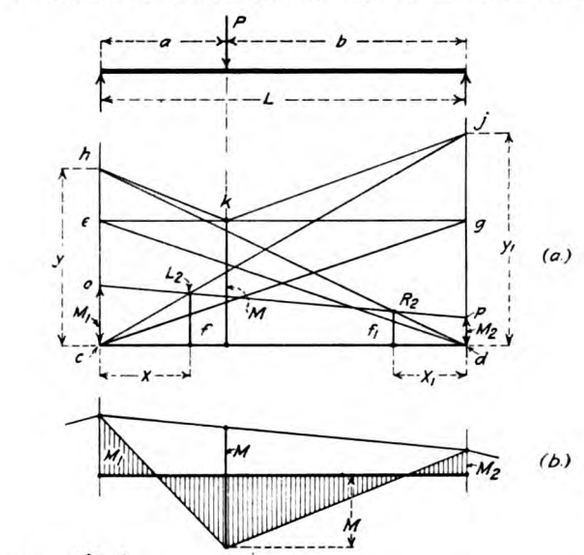


$M = \frac{1}{8} WL^2$

Proof: $f = M \cdot \frac{2X}{L}$ $f_1 = M \cdot \frac{2X_1}{L}$ $M_1 = f + (f - f_1) \frac{X}{L-X-X_1} =$

$2M \frac{X}{L} \cdot \frac{L-2X_1}{L-X-X}$ $M_2 = 2M \cdot \frac{X_1}{L} \cdot \frac{L-2X}{L-X-X_1}$

FIG. 2. DIAGRAM FOR UNIFORM LOADING.



$M = P \cdot \frac{a(L-a)}{L}$

Proof:- $y = M \cdot \frac{L+a}{L}$ $y' = M \cdot \frac{2L-a}{L}$ $f = y' \frac{X}{L} = M \cdot \frac{2L-a}{L} \cdot \frac{X}{L}$

$f_1 = y \cdot \frac{X_1}{L} = M \cdot \frac{L-a}{L} \cdot \frac{X_1}{L}$ $M_1 = f + (f - f_1) \cdot \frac{X}{L-X-X_1} =$

$M \cdot \frac{2L-a}{L} \cdot \frac{X}{L} + M \left(\frac{2L-a}{L} \cdot \frac{X}{L} - \frac{L+X}{L} \cdot \frac{X_1}{L} \right) \cdot \frac{X_1}{L-X-X_1} =$

$M \cdot \frac{X}{L} \cdot \frac{2L-a-3X_1}{L-X-X_1} = P \cdot \frac{a(L-a)}{L} \cdot \frac{X}{L} \cdot \frac{2L-a-3X_1}{L-X-X_1}$

$M_2 = P \cdot \frac{a(L-a)}{L} \cdot \frac{X_1}{L} \cdot \frac{L+a-3X}{L-X-X_1}$

FIG. 3. DIAGRAM FOR CONCENTRATED LOAD.

Uniform Loading. The method of obtaining the bending moments for span L_2 uniformly loaded is illustrated in Fig. 2. Compute, then, plot to any convenient scale, the moment, M at $\frac{L}{2}$, as if the beam was discontinuous, and draw lines ab and bc. Where these

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lines cut their respective verticals L_2 and R_2, two points are determined, enabling the bending moments M_1 and M_2 at the intermediate supports, to be deduced, by drawing the line *de* through these points as shown in (*a*). It is then a simple matter to construct the bending moment diagram for the entire span, requiring the construction of the parabola as in (*b*).

Concentrated Loads. Referring to the same span L_2, as discontinuous, the effect of a concentrated load P, will now be taken into consideration (Fig. 3), M in this case being used to indicate the bending moment directly at the point of application of the load. Having

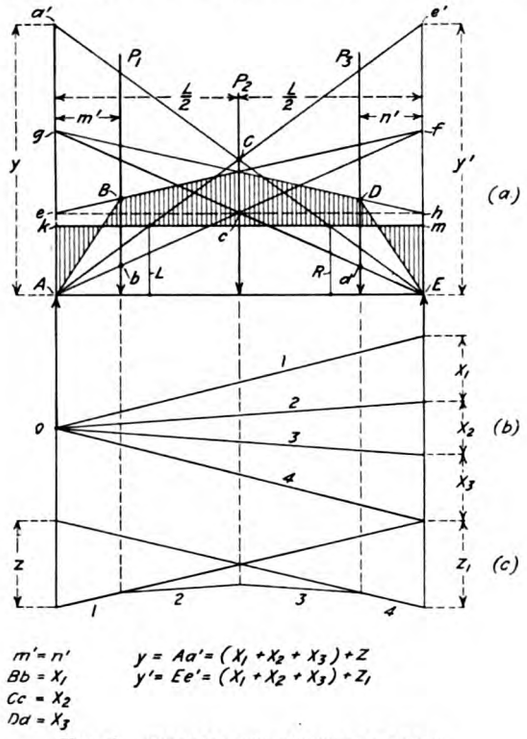

FIG. 4. DIAGRAM FOR IRREGULAR LOADS.

plotted the value of M in (*a*), draw *eg* parallel to the base *cd*. Join *cg* and *ed*, and then draw *hk* parallel to *ed* and *kJ* parallel to *cg*. Join *cJ* and *dh* and where these lines cut their respective verticals L_2 and R_2, draw the line *op*. The negative bending moments M_1 and M_2 can then be scaled off, and the bending moment diagram (*b*) constructed.

Irregular Load Systems. In Fig. 4, a system of concentrated or superimposed loads, P_1, P_2, and P_3 is considered. In order to apply the graphical method to this case, the bending moment diagram *ABCDE* for the span, irrespective of the beams being continuous, is plotted. After this has been done, a special construction is required in order to find the positive and negative moments due to the continuity of the beam. The method is as follows: Produce line *BC* in both directions, until it intersects the continuation lines of the supports at *e* and *f*. By a similar reasoning, using line *CD*, points *g* and *h* are determined. Now connect *g* and *E*, *A*, and *f* and *E* and *h* by means of straight lines. These operations serve for determining the three points *b*, *c*, and *d*. Symbolizing the distances *Bb*, *Cc*, and *Dd* by X_1, X_2, and X_3, respectively, plot them along the line of one of the supports and with a pole distance equal to the span, drawn the polar diagram (*b*) from which diagram (*c*) is constructed. Now lay off y and y' as shown in the figure, and draw line $a'E$ and Ae'. Where these lines cut the respective lines produced from the inflection points L and R, the necessary two points are obtained to determine the direction of line *km*, completing the diagram.

So far the bending moments for only one span have been shown diagrammatically. The moments at the supports of a continuous beam have been deduced in Fig. 5 and 6 and can be determined easily. The simplest procedure for obtaining these moments is to derive the moments for the loaded span, by the means explained above, the second element requiring recognition of the

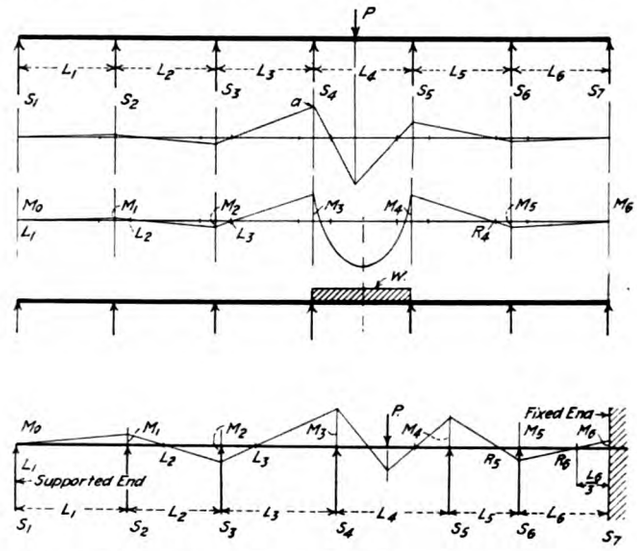

FIG. 5. MOMENTS IN CONTINUOUS BEAM RESULTING FROM A CONCENTRATED LOAD.

remaining inflection points, which governed the direction of the lines instrumental in obtaining these moments. To simplify explanations, the arbitrary term, instrumental line, will be introduced for want of better terminology, there being no standard technical term that can be used to designate this kind of a line. Considering the span just to the left of the loaded span, from the point of greatest bending moment (*a*), previously found, the instrumental line is drawn through the inflection point L_3, intersecting the support S_3, M represents the bending moment at support S_3 due to the loaded span L_4. The rest of the instrumental lines are drawn in the same manner, with the exception of the end spans, as shown. It will be noticed, from an inspection of the instrumental lines, that those to the left of the loaded span pass through the L inflection points, while those to the right utilize the R inflection points.

The foregoing principles will now be applied to the case of a continuous beam with three spans, the supports being all of the same level. It is upon this as-

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sumption, namely, that the supports are all on the same level, the calculations are based, since a slight subsidence of one or another of the supports, considerably changes the bending moment at any section of the beam.

By a course of investigation similar to that indicated in Fig. 1, the inflection points are located, through the aid of which the effects of the different conditions of dead and live loading are obtained, these effects being investigated separately. Each step taken is shown in its consecutive order, the final diagram representing the bending moment as a whole, being the outcome of superposing the various other diagrams.

Explanation of Fig. 6. A continuous beam of three spans, the end spans being equal and the beams subjected to both dead and live, concentrated or superimposed loads.

(*a*) Inflection points established.
(*b*) Concentrated dead load on span L_1 considered.
(*c*) Concentrated dead load on span L_2 considered.
(*d*) Effect of combined concentrated dead loading of the three spans.
(*e*) Concentrated live load on outer spans taken into consideration.
(*f*) Concentrated live load on centre span taken into consideration.
(*g*) Diagrams (*e*) and (*f*) combined.
(*h*) The positive areas of (*g*) combined with diagram (*d*) upturned.
(*i*) The negative areas of (*g*) combined with diagram (*d*) upturned.
(*j*) The final diagram resulting from the combination of (*h*) and (*i*).

TABULATION

Span (1) with dead load..... -1240
Span (2) with dead load..... -1640
Spans (1) and (2) with (3)..... $-1240-1640+340=-2540$
Span (1) with live load..... $-1240\times\frac{2100}{980}=-2654$
Span (2) with live load..... $-1640\times\frac{2550}{1190}=-3514$
Spans (1) and (2) with live load.. $-2654-3514=-6168$
Spans (1) and (3) with live load.. $-2654+728=-1926$
Span (1) with dead load..... $+340$
Span (2) with dead load..... -1640
Spans (1) and (2) with (3)..... -2540
Span (1) with live load..... $+340\times\frac{2100}{980}=+728$
Span (2) with live load..... -3514
Spans (1) and (2) with live load.. $+728-3514=-2786$
Spans (1) and (3) with live load.. -1926

Explanation of Fig. 10. Continuous beam of two unequal spans, carrying both dead and live uniform loads.

(*a*) Inflection points established.
(*b*) Uniform dead load on span L_1 considered.
(*c*) Uniform dead load on span L_2 considered.
(*d*) Diagrams (*b*) and (*c*) combined.
(*e*) Uniform live load on span L_1 taken into consideration.
(*f*) Uniform live load on span L_2 taken into consideration.

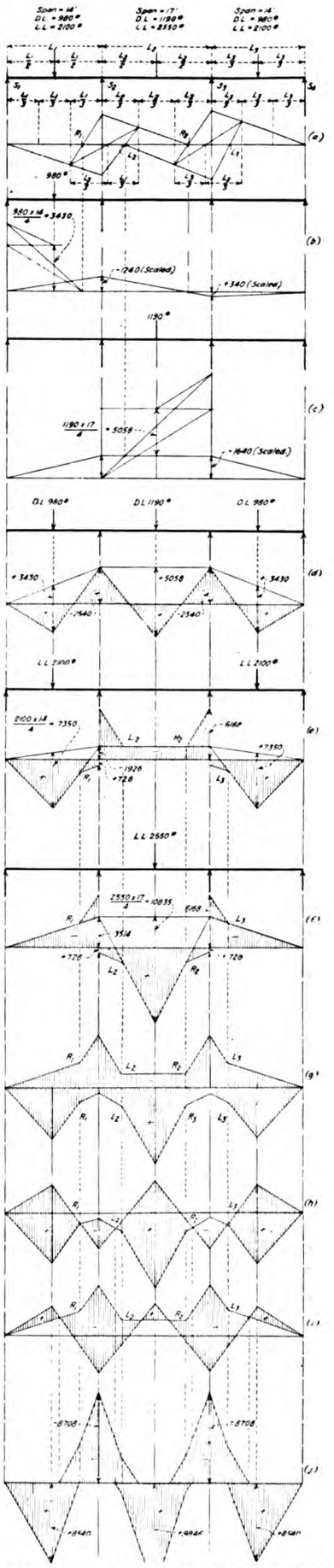

FIG. 6. ANALYSIS OF STRESS IN CONTINUOUS BEAM OF THREE SPANS WITH END SPANS EQUAL.

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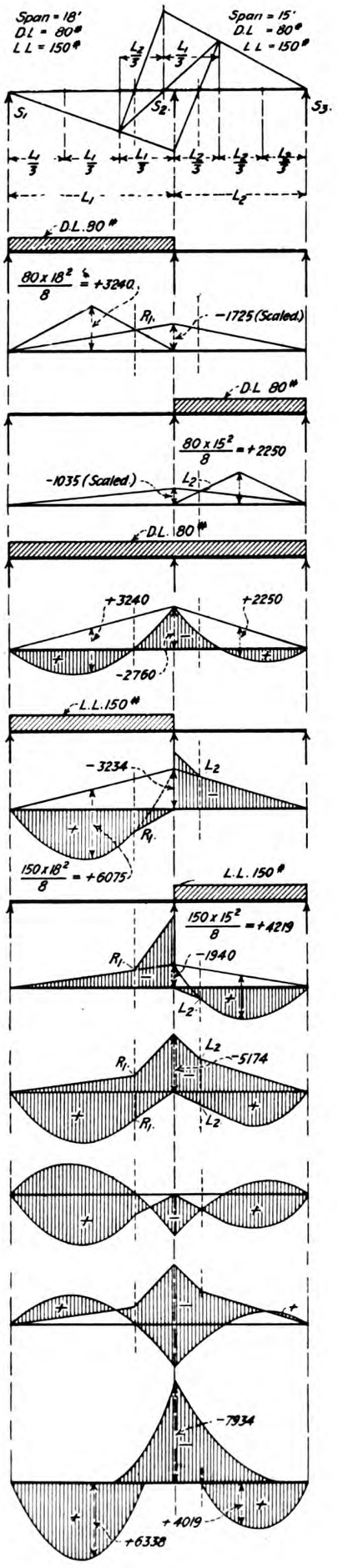
Fig 10



(*g*) Diagrams (*e*) and (*f*) combined.

(*h*) The positive areas of diagram (*g*) combined with diagram (*d*) upturned.

(*i*) The negative areas of diagram (*g*) combined with diagram (*d*) upturned.

(*j*) The final diagram resulting from a combination of diagrams (*h*) and (*i*).

TABULATION

Span (1) with dead load..... −1725

Span (2) with dead load..... −1035

Spans (1) and (2) with dead load. −2760

Span (1) with live load..... $-1725 \times \frac{150}{80} = -3234$

Span (2) with live load..... $-1035 \times \frac{150}{80} = -1940$

Spans (1) and (2) with live load.. −5174

The complete assembling of such a construction may interfere with the pet theories of many, due to the fact of their being no points of contra-flexure shown. Those thoroughly conversant with the behavior of live loads of a variable nature, know that what would be the positions of the points of contra-flexure when carrying a full live load, would be considerably stressed when only partly loaded. The most noteworthy feature of the diagram is that it represents the greatest bending moment that can occur at any section of the beam by translation of the load.

In conclusion, I wish to state that it is not my desire to give the impression that I have derived any new theory upon this subject. On the contrary, the method is based upon the combination of a series of perfectly familiar elementary formulae, and is a matter of common knowledge in Europe, though little known here. The purpose of this article is to show that by a careful analysis of the facts outlined, essential accuracy may be obtained without delving into laborious calculations. At present the usual method employed is either to assume the spans as discontinuous instead of extending unbroken over the supports, allowance being made for the negative moment in accordance with the judgment of the engineer, which method is based on a fallacy, or else to use the tentative formulæ now in common use with large factors of safety.

Numerous articles have been written on the merits and demerits of continuous beams and research is continued. But with all the diversity of opinion upon this subject, to the impartially-minded engineer, it is evident that a structure designed in a manner that will permit of a saving of 25 to 30% of the material in comparison with other types and yet fulfill all the requirements in regard to strength and durability is to be preferred, since it is the most economical.

The employment of continuous beams is opposed in some quarters because of the danger of an unequal settlement causing material changes in the stresses. The proper way to guard against this danger, however, is by a study of the structural geology of the region, and by greater care in the design of the foundations, rather than by condemning the use of continuous beams.

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The Standardization of Small Drainage Structures at Sausalito, California

By T. H. CLAUSSEN*

In October 1915 a good deal of residential street and foot-path work was contemplated in Sausalito. In making investigations looking toward the most economical structures and materials, castings for use in drainage and sewer work had to be considered. When the lists of standard patterns carried by the different foundries were examined, its was found that no patterns especially suited to this work were carried in stock, the choice being restricted to about nine patterns designed mostly for heavy work in large cities and under severe traffic conditions.

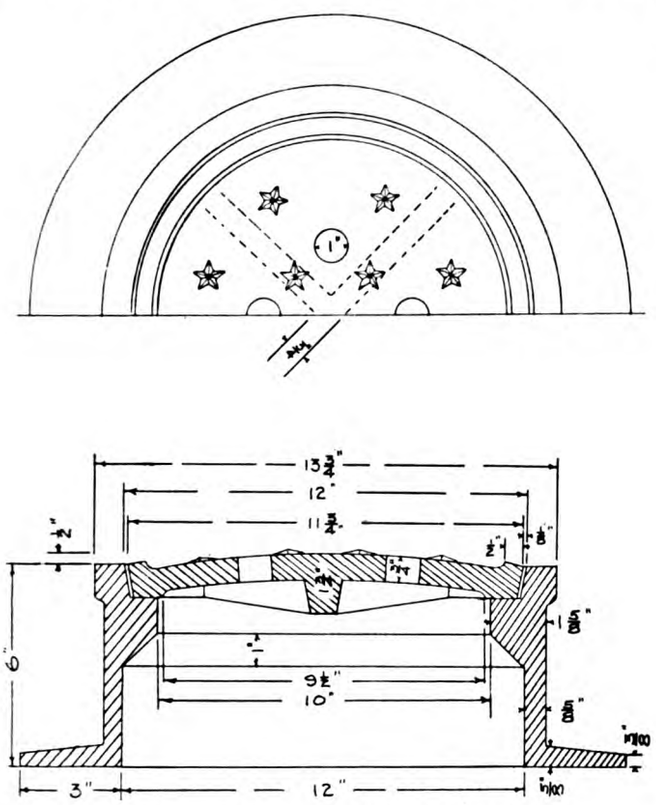

FIG. 1. LAMPHOLE FRAME AND COVER.

It was felt to be desirable that new patterns be designed. In order that the cost of drainage structures, which is an important item in street-improvement work, might be reduced and that the cost of the patterns should not be so great as to nullify the economy in metal (the town would be using only a few of these structures at a time), and since the adoption of a standard set of designs by a number of communities would make it worth while for the foundries to carry the standard patterns in stock, a movement was started by the town engineer to have such a set of standards adopted. An appeal was made to the engineering journals, the town engineers of several municipalities, the foundries, and the League of California Municipalities. The first responded well, the second not at all, the third splendidly, and the fourth is now considering the matter.

Pending further action, the first new structure, the lamp hole shown in Fig. 1, was designed to meet the needs of a large sewer district where the cost of the pattern could be divided among a fairly large number of castings. No novelty or particular excellence of design is claimed for this structure. It is shown merely with the hope that it, or an improved substitute may help toward the building up of a set of standard designs.

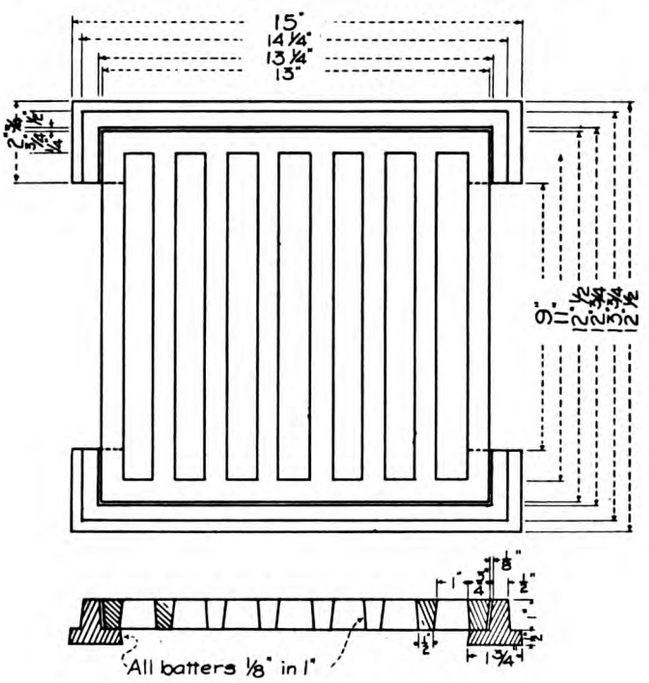

FIG. 2. GRATING FOR PEDESTRIAN TRAFFIC.

Fig. 2 shows a more novel structure for use on foot paths, and in places where light traffic may be expected. It will be noted that the supporting edges extend along one side only. It is intended that the cost of much unnecessary metal may thus be saved. At the same time the frame is elastic, accommodating gratings of varying lengths, although of the same width. Credit for the idea belongs to H. Rosenthal, of the office of the city engineer of San Francisco. A frame consisting merely of four corners has also been suggested by Mr. Rosenthal.

*Sausalito, California, formerly office assistant to the town engineer of Sausalito.

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It is possible that the saving of metal resulting from the standardization of drainage structures would be small, but oddly enough, this standardization would permit that variety of choice, and economy of selection which is the ideal of designers planning drainage works, especially on steep hillsides where the water must be kept under particularly good control.

It may be noted that the foundryman's catalogue is used extensively in small towns as a substitute for a system of standards. In discussing the subject with the representative of one foundry which publishes the most complete, and best arranged catalogue that we received, it was found that many engineers specify the type of structure to be used in an improvement by merely referring to this company's catalogue.

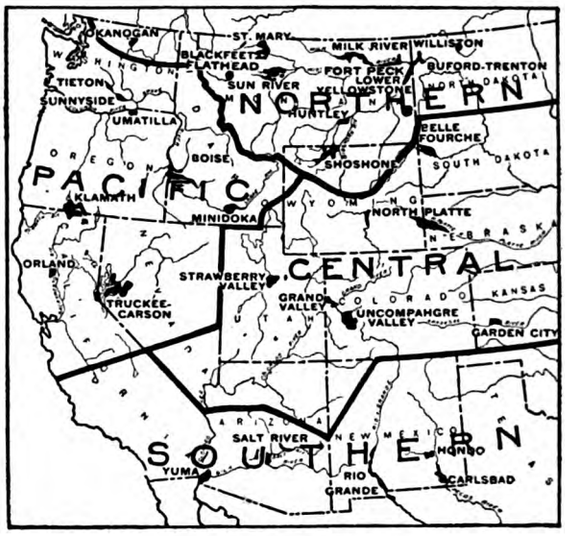
The structures shown were designed by myself under the supervision of L. L. Hohl, town engineer of Sausalito.

The lightest-section arch-dam in the world is the Medlow dam, on Adams creek, in the Blue mountains of New South Wales. The structure is of concrete and is 65 ft. high from the foundation to the top of the parapet. The up-stream face is vertical. The wall is 8.96 ft. thick at the base, tapering on the down-stream face to 3.5 ft. thick at a height of 29 ft., keeping that width to the top water level and finishing with a parapet wall 1 ft. thick for the remaining 3 ft. of height. It will be seen that this gives a considerably lighter section than the old Bear Valley dam in California, now replaced by a multiple-arch structure, which was 60 ft. high, 20 ft. thick at the foundation and tapered to 2.5 ft. at the top. The Bear Valley dam, however, was built with a radius of 335 ft., while the Medlow dam on account of the narrow gourge has a radius of only 60 ft. The maximum pressure for the Bear Valley dam was 53 tons per sq. ft., while the maximum pressure for the Medlow dam is 12 tons per sq. ft. The dam was designed by the use of the formula $T = \frac{RP}{S}$, where T is the thickness of the wall at any elevation, R is the radius in feet, P the water pressure in tons per sq. ft. and S the stress in tons per sq. ft., in this case taken as 12. The mixture used for the concrete was approximately 1:3:3. The catchment area is 1150 acres, the area of the reservoir when full is 12 acres, and its capacity 67,000,000 gallons. The cost of the dam exclusive of clearing the site, supervision, and engineering was $13,400.

Costs of cleaning weeds from railroad track are given in *Aera,* the official journal of the American Electric Railway Association. Twelve companies reported on the use of manual labor, the cost ranging from $18.30 to $75 per mile, with an average of $47. Nine companies reported on the use of chemicals, the cost ranging from $6 to $43.55 per mile, with an average of $26. Five companies gave figures on the use of a weed burner, the cost ranging from $4.66 to $15 per mile, with an average of $9. With manual labor the work has to be done from one to three times per year, but the track is left in the cleanest condition. Burning has to be repeated about as often as hand weeding and the track is left in an unsightly condition. Chemicals have the most lasting effect, the cost of treatment decreasing during the second and third years.

MAP OF RECLAMATION SERVICE PROJECTS

The accompanying map taken from the *Reclamation Record,* shows the situation of the main projects of the U. S. Reclamation Service, and also the administrative divisions under which they are grouped. The four divisions are under the supervision of the chief of construction, whose headquarters are at Denver, and who is the field executive of the director and chief engineer. In each division there is a senior engineer in charge of one of the more important projects in that



MAP SHOWING PROJECTS.

division, who is expected to be fairly familiar with the problems in all the projects of his division, and to be available in a consulting capacity in connection therewith upon short notice, although his time is given mainly to the management of the project where his headquarters are situated.

The boundary lines of each division are determined primarily by the convenience of railroad comunication. A secondary consideration, which usually conforms with the first, is the desirability of including the drainage areas of all projects in a district, within that district. The headquarters of the senior engineer for the northern division are at Fort Shaw, Montana; for the central division at Denver, Colorado; for the southern division at El Paso, Texas, and for the Pacific division at Boise, Idaho.

Cement mortar is used on the Canal Zone to plug cavities in trees that might otherwise collect water and serve as breeding places for mosquitoes. A 1:4 mixture is employed for ordinary-sized cavities, while the volume of mortar needed for large ones is reduced by using pieces of rock in the aggregate.

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Operation of Imhoff Tanks and Other Sewage-Disposal Plants

By F. V. HAMMERLY *

Although much has been written about the design, construction, and the fundamental theory of sewage-disposal tanks, the published data regarding the practical operation of such tanks is small, while a large part of what has been published has been in the line of adverse criticism. Because of the interesting principle of the decomposition of organic matter upon which it depends, the question of the design of the sewage-disposal tank monopolizes the attention. Not until after the tank is put into actual operation does it become apparent that management is fully as important for successful operation as the design. The designing engineer is usually interested only in planning a plant to meet the conditions in the particular community and he is frequently unable or else fails to emphasize the care necessary for its successful operation when constructed. Thus the importance of the design of the plant becomes exaggerated at the expense of its operation. The first unsatisfactory results arising from the ignorance or neglect of an unskilled operator are often a signal for unjust criticism of the designer, or may cause the whole system to be condemned. This unfortunate condition has caused a number of properly designed disposal plants to fall into disrepute.

Most of the Pacific Coast communities that have found it necessary to employ sewage-disposal tanks have appreciated the importance of engaging the best trained engineers to design these tanks. The tanks, therefore, have on the whole been properly designed, but through waning interest or misinformation these communities have usually failed to secure skillful management in their operation.

Most attendants at sewage-disposal plants have acquired a surprisingly large amount of misinformation as to their operation, besides being almost entirely destitute of knowledge regarding the results that can be obtained by tank processes. That disposal tanks operate 'automatically' and without any attention is the generally accepted idea among untrained men. This is largely due to the exaggerated claims made by the builders of sewage-disposal tanks, together with the common practice of gauging the results of the different tank processes by comparing the composition of the sewage and of the effluent, rather than by following the sewage through the various processes to ascertain what physical as well as chemical changes have been effected.

The function and operation of disposal tanks have been exaggerated so persistently that the term 'sewage-disposal tank' is connected, in the mind of the layman, with the complete 'automatic' clarification and purification of sewage by tank processes. It is only necessary to inspect and investigate the tank processes, and to ascertain the physical as well as chemical changes to perceive the fallacy of such ideas.

Typical American domestic sewage contains by weight 800 parts of solid matter per million parts of water; 500 parts of this solid matter occurs in solution and is not affected by purely mechanical treatment; 150 parts is either so finely divided that in practice it cannot be separated from the sewage by sedimentation or else is in true colloidal condition; 50 parts is composed of settling inorganic solids and the remaining 100 parts occurs as settling organic solids. The total solid matter amounts to only a fraction of 1% of the raw sewage, and of this, the putrefiable settling organic matter is responsible for most of the difficulties of the sewage disposal problem.

Organic matter cannot be destroyed. It can only be changed in physical form, or else converted from one compound into several having entirely different properties and chemical compositions. Whatever the change may be there will be no loss of matter, and the aggregate weights of the parts into which a substance is divided will be equal to its original weight. The settling solids must be removed and disposed by such methods that the process employed and the resulting products do not constitute a public menace or nuisance.

The processes which go on in the sludge chamber of an Imhoff tank are essentially different from those in a single-story septic tank. The decomposition of the sludge in an Imhoff tank forms large quantities of gas.

This is mainly methane and carbonic acid gas with only a little hydrogen sulphide. This is because the supernatant solution surrounding the sludge is renewed very slowly. It becomes thoroughly septic. The albuminous matter that has been set free is decomposed and as this is not renewed, no more hydrogen sulphide can be formed.

In the Imhoff tank, clarification of the sewage takes place in the upper or sedimentation chamber from which the sludge is drawn off continuously and automatically. The sewage passes through the settling chamber in about two hours. Because of this brief period putrefaction of the effluent is reduced.

As soon as the sludge enters the lower or sludge chamber the process of anaerobic decomposition begins. The complete decomposition of the sludge is effected in from three to eight months. The putrescible organic matter is converted into stable compounds. The sludge becomes finely divided during the process of decomposition, but it consolidates into a dense mass after this process is completed. The thoroughly decomposed sludge occupies but 25% of its original volume, although its weight is 75%

*753 Monadnock Bdg., San Francisco.

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of the original amount. A disposal tank that shows a greater loss of weight will be found to change the sludge to a colloidal condition, which allows it to escape in the effluent. The reduction in volume is due to the disintegration and consolidation of the sludge rather than to the escape of the products of decomposition either as gases or as soluble compounds. Thoroughly decomposed sludge is black in color, due to the iron sulphide it contains, has an oily appearance, gives an alkaline reaction, has an odor similar to warm wax or tar, and is easily dewatered as it is quite porous because of the entrained gas. It contains 25% of dry matter as compared with 5% in fresh sludge. It should be noted that the quantity of organic material reduced by anaerobic decomposition is less important than the desired qualities acquired by the sludge that has undergone septification.

The period that elapses from the time a tank is placed in operation until it begins to deliver good sludge is known as the ripening period. It is usually marked by excessive scum formations and floating scum. It is possible to decrease this ripening period considerably by inoculating the tank with a quantity of good sludge. About the amount of one week's accumulation of fresh sludge is sufficient to effect the inoculation of a new tank. This same method can be used to cause a troublesome tank to deliver good sludge. Inoculation is also accomplished with smaller amounts of good sludge, by combining fresh and properly decomposed sludge in the proportion of 1:1 and placing the mixture in the tank, allowing it to remain for one week. The mixture will by that time become sufficiently decomposed to permit the addition of an equal amount of fresh sludge. This process may then be continued until a sufficient volume of properly decomposed sludge has been obtained.

In the earlier part of the ripening period it frequently happens that acid decomposition occurs. This may be due to the composition of the fresh sewage, which is usually acid, and also to the fact that conditions favorable to the bacteria that produce an acid sludge are usually present in a new disposal tank. Acid decomposition is characteristic of decomposing fecal matter derived from a vegetable diet unless the tank is inoculated with the proper bacteria, while a meat diet tends toward alkaline decomposition.

This process of acid decomposition is undesirable. It is marked by slow decomposition, producing a sludge that is hard to dewater, and having an objectionable odor. The result of acid decomposition is the formation of an unusually large amount of floating sludge and a scum of resistant dark-colored froth that rises in the gas vents far above the tank water-level. This phenomenon never occurs in a properly operated tank.

Proper sludge decomposition depends not so much on the composition of the sewage, its volume, or the relation of the sewage to the sludge, as on the biological condition of the sludge itself. The composition of the sewage may influence the length of the ripening period, but sooner or later the proper organisms will predominate and the desired sludge decomposition will result, even if the sewage is continuously acid. Once good decomposition has been established it must be maintained by providing the necessary bacteriological environment.

Successful operation of the Imhoff tank will be attained if the following rules are consistently observed:

1. Cleaning of Settling-Chamber. The inclined partition-walls should be cleaned every second day. This is best accomplished with a rubber squeegee. All the adhering material that settles on the walls must be pushed down through the slot. Care should be exercised in using the squeegee that the solid material adhering to the walls is not agitated greatly; it takes a long time for it to settle. Frequently it will not settle at all. It is necessary to keep this portion of the tank clean, for if the fine material accumulating here is allowed to remain it will decompose, forming H_2S gas in the process and interfering with the deposition of the fresh sludge.

Suspended matter in the form of a frothy scum sometimes rises to the surface behind as well as in front of the scum-boards. This is a sign either that the inner surface of the settling-chamber has not been kept sufficiently clean or that the sludge has risen to the slot-level, clogging the slot and allowing sludge to accumulate in the settling-chamber. If the latter is the case it will be necessary to discharge sludge immediately. All floating material, such as matches, corks, and the scum that accumulates behind the baffle-boards, should be removed and thrown into the scum chamber.

2. Changing the Direction of Flow. In plants where two or more sludge chambers are in operation, or when a tank is being used to capacity, the direction of the flow in the tank should be reversed at least once a month. This is necessary in order that the sludge may be evenly distributed in the sludge chambers.

3. Care of the Scum Chamber. Upon the surface of the scum chamber a relatively thin layer of scum will form. This scum should be broken thoroughly every second day and violently agitated, and then pushed into the digestion chamber. Usually the greater part of this scum will sink of its own accord when the entrained gas is released. The gas may be released from the floating scum by directing a stream of water upon it. If, in spite of frequent and thorough agitation, the scum layers become too deep, dense, and hard, and cannot be deposited in the digestion chamber, they should be removed by means of a shovel to the sludge drying beds. The formation of excessive scum layers occurs usually only during the ripening period and will cease as soon as good decomposition has been established within the sludge chamber.

There is another phenomenon, that of 'foaming or floating sludge,' that must be distinguished from the scum layers. The foaming scum is similar in appearance to a mass of resistant, dark-colored soap bubbles. It is light and frequently rises in the gas vents far above the tank water-level. It consists simply of sludge in an improper state of decomposition and possessing a sufficiently high viscosity to enable it to imprison its gases firmly. Its occurrence indicates that the sludge should be dis-

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charged and possibly that the tank should be inoculated with proper decomposing sludge.

4. Rate of Deposition of Sludge. The rate of deposition of the sludge in the digestion chamber should be watched carefully and the elevation of its surface should be determined at least every ten days. This may be done by means of a weighted board or a sheet-iron plate attached to a wire or rod. The determination of the sludge level in this manner is not absolutely reliable because the transition between the sludge and supernatant liquid is difficult to perceive. A more accurate method is to attach large-mouthed bottles, fitted with stoppers, to a measuring rod. These bottles should be about three inches deep and firmly attached about three inches apart. These bottle stoppers are inserted and lines attached to them. Then the measuring rod is quietly lowered into the sludge chamber and the stoppers removed, the bottles filling in their separate positions. The rod is then removed. This device gives a vertical section of the sludge chamber and shows the exact level of the sludge.

5. Removal of Sludge. Sludge should be discharged from the sludge chambers at least every four weeks. This procedure will effect the maximum utilization of the sludge-drying beds. Only the thoroughly digested sludge at the very bottom of the sludge chamber should be withdrawn. A sufficient amount of the properly decomposing sludge must always be left to insure the maintenance of a proper bacteriological environment. If the entire volume of the sludge were removed at any one time, the entire process of ripening or establishing effective biological action would have to be repeated, together with all its excessive and troublesome scum formations.

In general the optimum position of the sludge level is about three feet below the slot-level. This level is best maintained by frequent withdrawals of small volumes of sludge. In any case the sludge should never be allowed to rise above the lower edge of the inclined diaphragm which limits the slot. Care must be taken not to allow the sludge to pass through the sludge-withdrawal pipe too rapidly, because the less well-digested and softer sludge near the surface in the sludge chamber may be forced out of the tank by the water pressure, rather than the more compact, thoroughly digested and viscous sludge at the bottom. In other words, if the sludge is withdrawn too rapidly an inverted cone of least resistance will form, and eventually only liquids, rather than solids, will pass from the tank.

6. Use of Perforated Pressure-Pipes. If the sludge should not flow readily through the sludge-removal pipes it may be loosened by forcing clarified sewage or fresh water through the perforated pressure-pipe in the bottom of the digestion chamber. Since proper decomposition is stimulated by constant stirring, or inoculation, the sludge at the bottom of the chamber is frequently agitated by a water-stirring system. According to Sabilla, excessive scum formations may be checked by the occasional use of this perforated pipe. When this is done, much of the gas in the sludge is allowed to escape and there is consequently less tendency for it to rise into the scum chamber. Furthermore, if the activity of the organisms in the sludge seem to be retarded, due to over-septification or excessive formation of the so-called enzymes or other by-products of their existence, the latter may be diluted by forcing fresh clarified sewage or water through the perforated pipe.

7. Refilling of Sludge Pipes. After each withdrawal of the sludge the pipes should be filled with fresh water or clarified sewage to prevent the pipes from becoming clogged with dry sludge. If the sludge pipes become clogged they may be cleaned by pushing a rod through them or by forcing water or clarified sewage through them under pressure.

8. Drying of Sludge. The depth of the sludge deposits upon the drying beds should not exceed 10 to 15 in. In dry weather the sludge should become spadable in a few days and should be removed from the bed. It is the best practice to remove the sludge as soon as dried and to prepare the drying bed immediately for re-use. The dry sludge may be used for fertilizer on lands or it may be used for filling in low places. Its chief value as a fertilizer is its property of being able to lighten heavy soils and to furnish humus to soils which are deficient in this respect. When deposited in fills, thoroughly digested sludge does not undergo putrefaction and will not cause any nuisance due to odor.

9. Resurfacing of Sludge-Drying Beds. Whenever the surface layer of the sludge-drying beds becomes clogged or is taken away in the removal of the sludge a new layer should be applied immediately. This feature is important in order that water draining from the bed may be removed quickly by seepage into the under-draining system.

10. Sampling and Testing of Sewage. Test samples of the sewage effluent should be taken frequently. From these observations the efficiency of the tank should be determined. Ordinarily this test should be made once a day, but occasionally it should be done throughout the day in order to determine the variation in the composition of the sewage. This should be done until the attendant knows under what conditions and at what time of the day the greatest efficiency is obtained. Care must be exercised in taking the sample to be tested. It should be representative of the sewage, part of the time taking all the stream that is flowing. Care must be used in dividing the test samples, and they should be thoroughly agitated when making the division.

11. Measurement of Sewage. Every disposal plant should be provided with a measuring weir, suitable orifices, or other devices for determining the rate of flow with reasonable accuracy. Whenever possible a recording self-integrating gauge showing the flow at all times should be installed.

12. Determining the Penetration of Scum Boards. The penetration of scum boards under the water surface should not be so great as to render ineffective part of the upper volume of the chamber or to increase immoderately the velocity in the slow-motion zone. Experiment alone will give the best depth of penetration.

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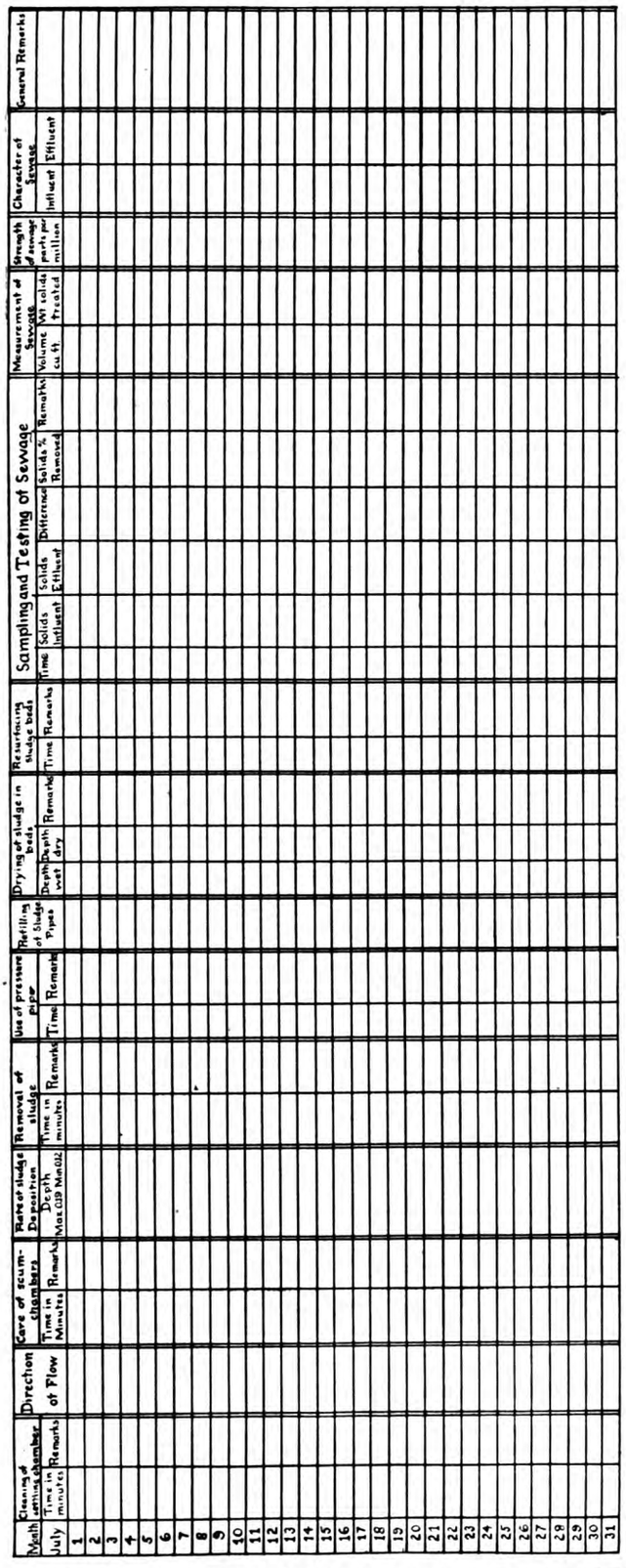

FIG. 1. FORM FOR RECORDS OF SEWAGE-DISPOSAL PLANTS.

Scum boards serve two purposes; to hold back light, floating material, and to distribute the stream with its load evenly as it enters the settling chamber.

13. Posting of Warnings. All disposal plants should be placarded with signs that will show the character of the plant distinctly. This will avoid any litigation that may result from carelessness on the part of inquisitive persons.

14. Tools. It is necessary that proper tools be furnished to the attendant. He should be instructed to wear rubber gloves whenever working about the plant.

15. Keeping Accurate Report. Successful operation of an Imhoff tank when once good decomposition has been established becomes largely a matter of routine. However an intimate knowledge of the actual operation of the tank is necessary for successful management. Such knowledge can be obtained only by keeping an accurate record of all operations. Such a record may be of great value to a community in case a suit should be brought because of the operating conditions of the plant. Fig. 1 shows a good form for the records.

It is regrettable that sewage-disposal works that are usually built with intelligence and skill frequently become the object of gross neglect. Ninety-nine per cent of the failures of these plants have been due to ignorance on the part of the management. Too often the money provided for the operation and maintenance of these plants is too small to permit the employment of a competent manager. The results of operation are therefore poor, the plant is not properly maintained, and matters proceed from bad to worse. Nevertheless, such conditions can be remedied easily by a little honest constructive effort.

[EDITOR'S NOTE. For a description of the Imhoff tank, the reader is referred to an earlier article by Mr. Hammerly, appearing in WESTERN ENGINEERING for April 1916.]

INACCURACY OF PRESENT SYSTEMS OF MEASURING NATURAL GAS

The United States Bureau of Mines, which has been conducting experiments on the measurement of natural gases at high pressures, has found there is, in many instances where Boyle's law is used, error as great as 10% or more. The volume of gas, according to Boyle's law, is presumed to vary inversely as the pressure that is applied to it. This is found to be true only for pressures close to atmospheric. Billions of cubic feet of natural gas are yearly measured at pressures greater than atmospheric. The Bureau of Mines says, regarding these figures, in its report:

Pressures of 300 lb. per sq. in. or greater are common. At 100 lb. per sq. in. an error of 3% has been made, at 200 lb. per sq. in. an error of 6%, at 375 lb. an error of 11%, and at 520 lb. an error of 15% has been made in many cases. Natural gas at these pressures is more compressible than a perfect gas. A concrete example will make the matter clear. If 50,000,000 cu. ft. of natural gas is measured per day at a pressure of 200 lb. per sq. in. and no correction is applied for the deviation from Boyle's law, then an error of about 3,000,000 cu. ft. is made.

German silver contains 60% copper, 21% nickel, and 19% zinc.

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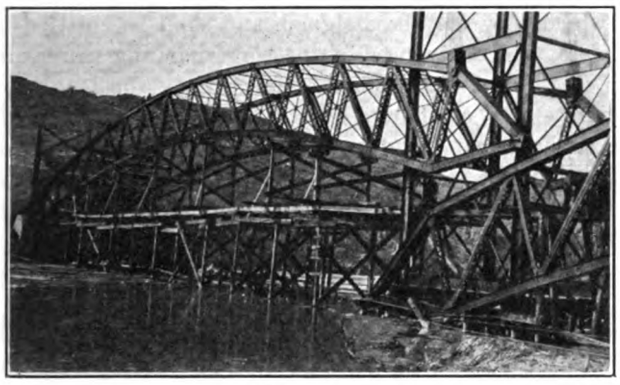
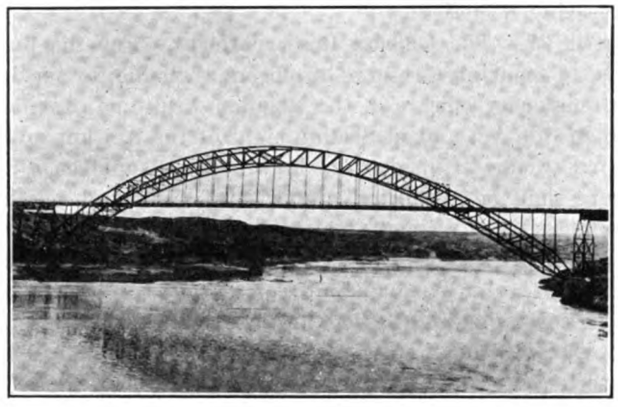
Three-Hinged Arch Steel Highway Bridge Over Colorado River at Needles, California*

The connecting link of the 'National Old Trails Highway,' recently constructed across the Colorado river, near Needles, San Bernardino county, California, is of unusual interest to engineers as well as to the general public. The main span of this bridge is the longest three-hinged arch span yet constructed in the United States. The centre hinge is of the ball and socket type, with spherical compression bearing. The main arch-span was erected as a three-hinged arch, and was then tied together at the centre hinge by thin ½-in. plates, which act as auxiliary leaf hinges. These do not restrict the vertical movement of the arch due to temperature changes, but they provide 6 sq. in. of tensile section across the centre hinge on each side of the arch truss, for additional rigidity against excessive wind-stress.



BRIDGE DURING CONSTRUCTION.



THE COMPLETED SPAN.

The arch trusses for the main span were erected on the ground with the end hinges in place, being built toward the centre of the stream in approximately a horizontal position and with one half-span overlapping the other half-span at the centre of the bridge. The temporary erection-tower which was built from material used later in the bridge-floor system was then used to raise the two half-spans to the desired position at the centre hinge. The entire bearing at the centre hinge is upon two spherical compression pieces 12 in. diam. The floor is supported vertically at each panel-point by the arch-trusses. It carries its own horizontal thrust due to wind stress to the steel-tower supports. Expansion joints are provided at each portal so that the floor system is free to act independently of the arch trusses except for vertical support.

Funds for the bridge were provided by an appropriation of $25,000 by the Federal Government, acting through the Bureau of Indian Affairs, and similar amounts by both the State of Arizona and the State of California. San Bernardino county guaranteed all excess cost above $75,000, and paid all expenses connected with the preliminary survey, drawing and approval of plans, and supervision of construction. The preliminary estimate of cost was $85,000. The actual contract price was $75,448, not including wing-walls, which were built by the two counties on either side of the river. The cost of engineering work, including preliminary surveys, preparation of design and supervision of construction, amounted to approximately $4500, making the total cost exclusive of wing-walls approximately $80,000.

The bridge was fabricated and erected by the Kansas City Structural Steel Co., Kansas City, Mo., with Thomas McCurnin as superintendent of construction. The designing engineer was J. A. Sourwine, of Sourwine and Mahoney, consulting engineers, San Bernardino county, California. The designs were checked and approved for the State of California, by A. V. Saph, of San Francisco. J. P. Kemmerer acted as construction engineer.

*From data furnished by G. A. Sourwine, San Bernardino, California.

Cost of fuel for locomotives amounted in 1914 to 11.05% of the total operating expense of the railroads. For railroads in the Western district the proportion was 12.40%, for the Southern district, 9.50%, and for the Eastern, 10.45%. The total expenditure for fuel was approximately $243,000,000.

Excavation of slides in the Panama Canal amounted to 14,937,336 cu. yd. between July 1, 1914, and May 1, 1916. At present about 1,000,000 cu. yd. is removed per month. The total canal excavation to May 1, 1916, was 247,261,864 cubic yards.

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Abstract of Act Authorizing National Engineering Reserve

The Army Reorganization Act, which became effective July 1, 1916, contains provisions for the organization of an Officers Reserve, including engineers. As soon as practicable after July 1, the War Department will issue an invitation to the engineers of the country to apply for commissions in the Reserve Corps of Engineers, and there will be available for those interested, complete information as to the requirements of commissions in the several grades from Second Lieutenant to Major, and for Master Engineers and Sergeants, and the method of procedure to secure commissions or enlistment. The following abstract of the portion of the Act relating to the Officers Reserve and the Enlisted Reserve Corps has been prepared by a Joint Committee of the National Engineering Societies:

Sec. 37.—The Officers Reserve Corps.—For the purpose of securing a reserve of officers available for service as temporary officers in the Regular Army, as provided for in this Act and in Section eight of the Act approved April twenty-fifth, nineteen hundred and fourteen, * * * there shall be organized, under such rules and regulations as the President may prescribe not inconsistent with the provisions of this Act, an Officers Reserve Corps of the Regular Army. Said corps shall consist of sections corresponding to the various arms, staff corps, and departments of the Regular Army. Except as otherwise herein provided, a member of the Officers Reserve Corps shall not be subject to call for service in time of peace, and whenever called upon for service shall not, without his consent, be so called in a lower grade than that held by him in said reserve corps.

The President alone shall be authorized to appoint and commission as reserve officers in the various sections of the Officers Reserve Corps, in all grades up to and including that of major, such citizens as, upon examination prescribed by the President, shall be found physically, mentally, and morally qualified to hold such commissions: *Provided,* That the proportion of officers in any section of the Officers Reserve Corps shall not exceed the proportion for the same grade in the corresponding arm, corps, or department of the Regular Army, except that the number commissioned in the lowest authorized grade in any section of the Officers Reserve Corps shall not be limited.

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The commissions of all officers of the Officers Reserve Corps shall be in force for a period of five years unless sooner terminated in the discretion of the President. Such officers may be re-commissioned, either in the same or higher grades, for successive periods of five years, subject to such examinations and qualifications as the President may prescribe and to the age limits prescribed herein: *Provided,* That officers of the Officers Reserve Corps shall have rank therein in the various sections of said Reserve Corps according to grades and to length of service in their grades.

Sec. 38.—The Officers Reserve Corps in War.—In time of actual or threatened hostilities the President may order officers of the Officers Reserve Corps, subject to such subsequent physical examinations as he may prescribe, to temporary duty with the Regular Army in grades thereof which cannot, for the time being, be filled by promotion, or as officers in volunteer or other organizations that may be authorized by law, or as officers at recruit rendezvous and depots, or on such other duty as the President may prescribe. While such reserve officers are on such service they shall, by virtue of their commissions as reserve officers, exercise command appropriate to their grade and rank in the organizations to which they may be assigned, and shall be entitled to the pay and allowances of the corresponding grades in the Regular Army, with increase of pay for length of active service, as allowed by law for officers of the Regular Army, from the date upon which they shall be required by the terms of their orders to obey the same: *Provided,* That officers so ordered to active services shall take temporary rank among themselves and in their grades in the organizations to which assigned, according to the dates of orders placing them on active service; and they may be promoted, in accordance with such rank, to vacancies in volunteer organizations or to temporary vacancies in the Regular Army thereafter occurring in the organizations in which they shall be serving. * *

Any officer who, while holding a commission in the Officers Reserve Corps, shall be ordered to active service by the Secretary of War shall, from the time he shall be required by the terms of his order to obey the same, be subject to the laws and regulations for the government of the Army of the United States, in so far as they are applicable to officers whose permanent retention in the military service is not contemplated.

Sec. 39.—Instruction of Officers of the Officers Reserve Corps.—To the extent provided for from time to time by appropriations for this specific purpose, the Secretary of War is authorized to order reserve officers to duty with troops or at field exercises, or for instruction, for periods not to exceed fifteen days in any one calendar year, and while so serving such officers shall receive the pay and allowances of their respective grades in the Regular Army: *Provided,* That, with the consent of the reserve officers concerned, and within the limit of funds available for the purpose, such periods of duty may be extended for reserve officers as the Secretary of War may direct. * * *

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Sec. 55.—The Enlisted Reserve Corps.—For the purpose of securing an additional reserve of enlisted men

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for military service with the Engineer * * * Corps * * * of the Regular Army, an Enlisted Reserve Corps, to consist of such number of enlisted men of such grade or grades as may be designated by the President from time to time, is hereby authorized, such authorization to be effective on and after the first day of July, nineteen hundred and sixteen.

There may be enlisted in the grade or grades hereinbefore specified, for a period of four years, under such rules as may be prescribed by the President, citizens of the United States, or persons who have declared their intentions to become citizens of the United States, subject to such physical, educational and practical examination as may be prescribed in said rules. For men enlisting in said grade or grades, certificates of enlistment in the Enlisted Reserve Corps shall be issued by the Adjutant General of the Army, but no such man shall be enlisted in said crops unless he shall be found physically, mentally and morally qualified to hold such certificate and unless he shall be between the ages of eighteen and forty-five years. The certificates so given shall confer upon the holders when called into active service or for purposes of instruction and training, and during the period of such active service, instruction, or training, all the authority, rights and privileges of like grades of the Regular Army. * * * And the Secretary of War is hereby authorized to issue to members of the Enlisted Reserve Corps and to persons who have participated in at least one encampment for the military instruction of citizens, conducted under the auspices of the War Department, distinctive rosettes or knots designed for wear with civilian clothing.

The President is authorized to assign members of the Enlisted Reserve Corps as reserves to particular organizations of the Regular Army, or to organize the Enlisted Reserve Corps, or any part thereof, into units or detachments of any arm, corps, or department in such manner as he may prescribe, and to assign to such units and detachments officers of the Regular Army or of the Officers Reserve Corps, herein provided for.

To the extent provided from time to time by appropriations, the Secretary of War may order enlisted men of the Enlisted Reserve Corps to active service for purposes of instruction or training for periods not to exceed fifteen days in any one calendar year: *Provided,* That, with the consent of such enlisted men and within the limits of the funds available for such purposes, such periods of active service may be extended for such number of enlisted men as may be deemed necessary.

Enlisted men of the Enlisted Reserve Corps shall receive the pay and allowances of their respective grades, but only when ordered into active service, including the time required for actual travel from their homes to the places to which ordered and return to their homes.

* * * * * * * * * * * * *

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PROPOSED BRIDGE ACROSS SAN FRANCISCO BAY

Preliminary plans have been made by an association of bridge engineers composed of Wilbur J. Watson & Co., of Cleveland, Ohio, William R. Davis, of Albany, New York, and Harlan D. Miller, of New York City, for a double-deck bridge across San Francisco bay. The Oakland terminal would be at First and Adeline streets. On the San Francisco side, the terminals would be: for vehicles, Second and Townsend streets, for overland trains, Third and Townsend, and for interurban trains Third and Market.

The upper deck would have two roadways for slow-moving trucks and one roadway for high-speed automobiles. The lower deck would have two tracks for overland trains and two for interurban trains. There would be sixty plain 250-ft. spans, two moveable 250-ft. spans, two 600-ft. spans, and 23 spans from 100 to 200 ft. long, 87 spans in all with a total of 5½ miles. Near the San Francisco shore the bridge would be high enough to permit the free passage of all but the largest vessels. These would be provided for by the two movable spans already mentioned, which would be of the bascule type. The maximum grade on the bridge would be 2½%. Wood-block pavement would be used for the roadway. All trains would be handled by electric traction.

It is believed that four years would be required to complete the bridge. The estimated cost is $22,000,000, which it is proposed to raise by organizing a 'bridge district' containing territory on both sides of the bay. Toll for the use of the bridge would be charged, and the proceeds used for interest, maintenance, and other charges. Plans have been submitted to the War Department and a Board of Army Engineers will hold public hearings at San Francisco regarding the project on August 15 and 16, and in Oakland on August 17 and 18.

COMPRESSIVE STRENGTH OF MORTARS AND CONCRETES

Contractors, engineers, and other users of cement will be interested in a publication, Technological Paper No. 58, issued recently by the United States Bureau of Standards on the compressive strength of portland-cement mortars and concretes. Concrete differs from most structural materials in that it is not manufactured at a mill or plant according to chemical formula under the observation of skilled specialists, subject to rigid inspection and test and to such control as to produce a uniformly homogeneous product. Furthermore, concrete is made from materials obtained from sources differing widely in the characteristics which affect its quality. The proportions of the ingredients; the amount of water used in mixing; the thoroughness of mixing; exposure to sun, rain, and wind; immersion in fresh water, sea-water, or other natural solutions—all affect the quality of the concrete. The paper contains the results of some 20,000 tests. Copies may be obtained by application to the Bureau of Standards, Washington, D. C.

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Engineers' Note Book

CHART FOR DETERMINING VELOCITY AND DISCHARGE OF UNLINED EARTH DITCHES

By GEORGE HENRY ELLIS*

The accompanying chart may be used for computing the velocity and discharge in unlined earth ditches 12 ft. wide on the bottom. Quantities have been computed from Kutter's formula, n being taken as 0.225, an average value for earth ditches in fair condition.

Thus for a canal 12 ft. wide flowing 2.5 ft. deep, with a slope of 0.00025 or practically 1.3 ft. to the mile, the velocity is found to be slightly over 1.5 ft. per second and the discharge, by interpolation to be approximately 64 cu. ft. per second. For a canal flowing 3 ft. deep, with a slope of 0.0003, or practically 1.5 ft. to the mile, the velocity is found by interpolation to be approximately 1.85 ft. per second and the discharge to be 100 cu. ft. per second. Again, given a canal with a slope of 0.0005 or 2½ ft. to the mile; required, the depth of water to give a discharge of 50 cu. ft. per second. By interpolation the depth of water is found to be approximately 1.8 ft. The corresponding velocity is approximately 1.8 ft. per second.

The diagram can also be used to solve such problems as, given a canal 12 ft. wide where the velocity is limited to 1.5 ft. per second, required, the depth and slope necessary to deliver 30 second-feet. The depth is found to be 1.35 ft. and the slope 0.0005 or 2½ ft. to the mile.

*Fort Shaw, Montana.

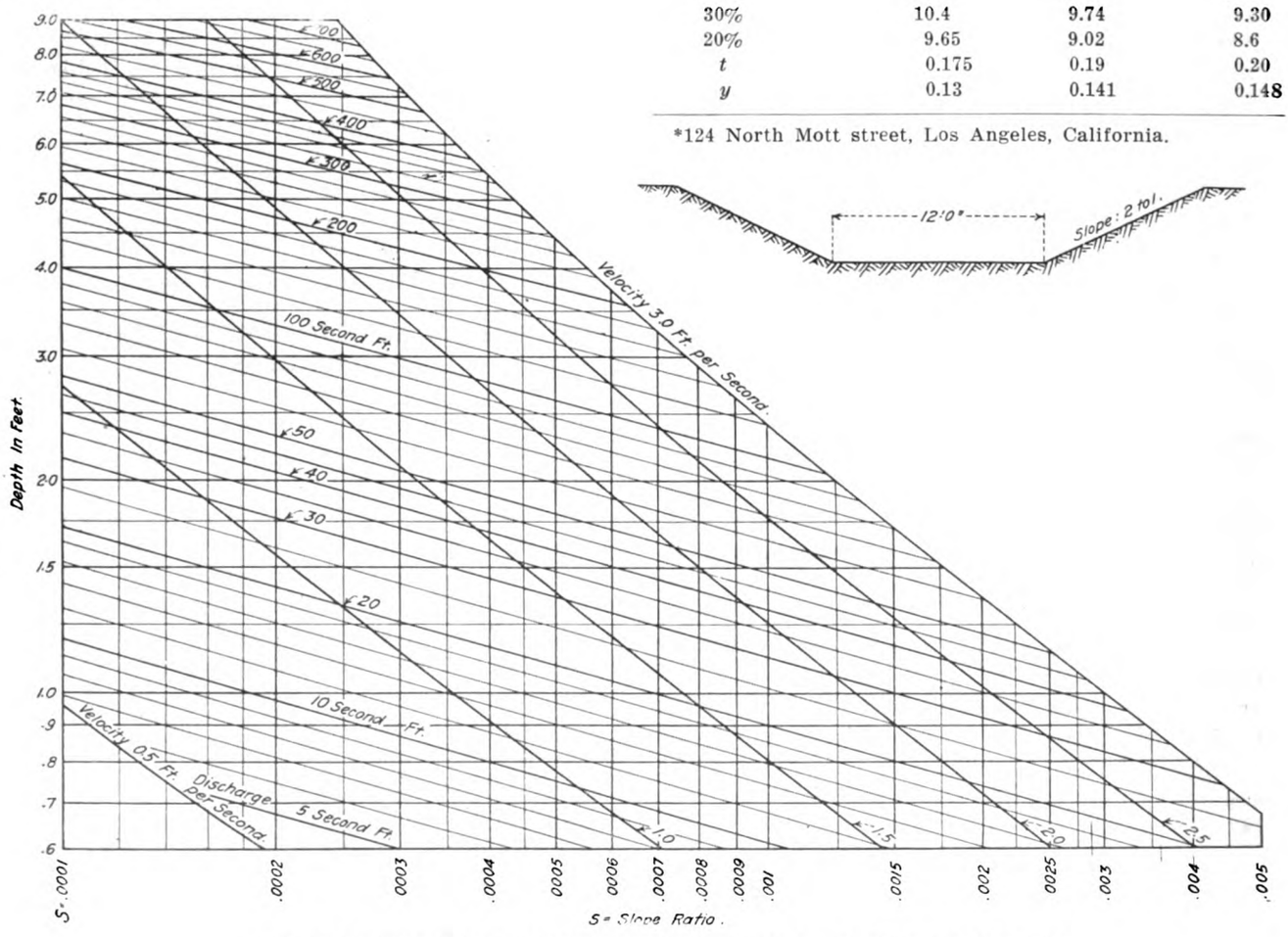

CHART FOR DETERMINING VELOCITY AND DISCHARGE IN EARTH DITCHES 12 FT. WIDE.

TABLE FOR COMPUTING QUANTITIES OF CEMENT AND AGGREGATE FOR ONE CUBIC YARD OF CONCRETE

By E. EARL GLASS*

The accompanying table is an extension of Fuller's Rule. The quantity, X, or the number of barrels of cement as computed from the table, will be found to check within 0.01 bbl. of the figures given in Taylor & Thompson's tables.

Let c = parts of cement.
s = parts of sand.
r = parts of rock or gravel.
S = sum of parts = $c+s+r$, as 1: 2: 4 mix, $S=7$.
C, t, and y are constants taken from table below.
T_s = tons of sand per cu. yd. of concrete.
T_r = tons of rock per cu. yd. of concrete.
Y_s = cu. yd. of sand per cu. yd. of concrete.
Y_r = cu. yd. of rock per cu. yd. of concrete.
X = bbl. of cement per cu. yd. of concrete.

Then $X = \frac{C}{S}$
$T_s = Xts$
$T_r = Xtr$
$Y_s = Xys$
$Y_r = Xyr$

Values of C.

Proportion of voids in broken stone or gravel	Volume of barrel of cement assumed		
	3.5 cu. ft.	3.8 cu. ft.	4.0 cu. ft.
50%	12.1	11.4	11.0
45%	11.8	11.1	10.6
40%	11.2	10.5	10.1
30%	10.4	9.74	9.30
20%	9.65	9.02	8.6
t	0.175	0.19	0.20
y	0.13	0.141	0.148

*124 North Mott street, Los Angeles, California.

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The value of t is based on an assumed weight of sand, rock, gravel of 100 lb. per cubic foot.

Example: Given a 1: 2½: 5½ mix, 40% voids in the rock, and 3.8 cu. ft. per bbl. of cement.

$1: 2\frac{1}{2}: 5 = 9 = S$

$C = 10.5$

$\frac{10.5}{9} = 1.17$ bbl. of cement per cu. yd. concrete.

$1.17 \times 0.19 \times 2\frac{1}{2} = 0.555$ tons of sand.

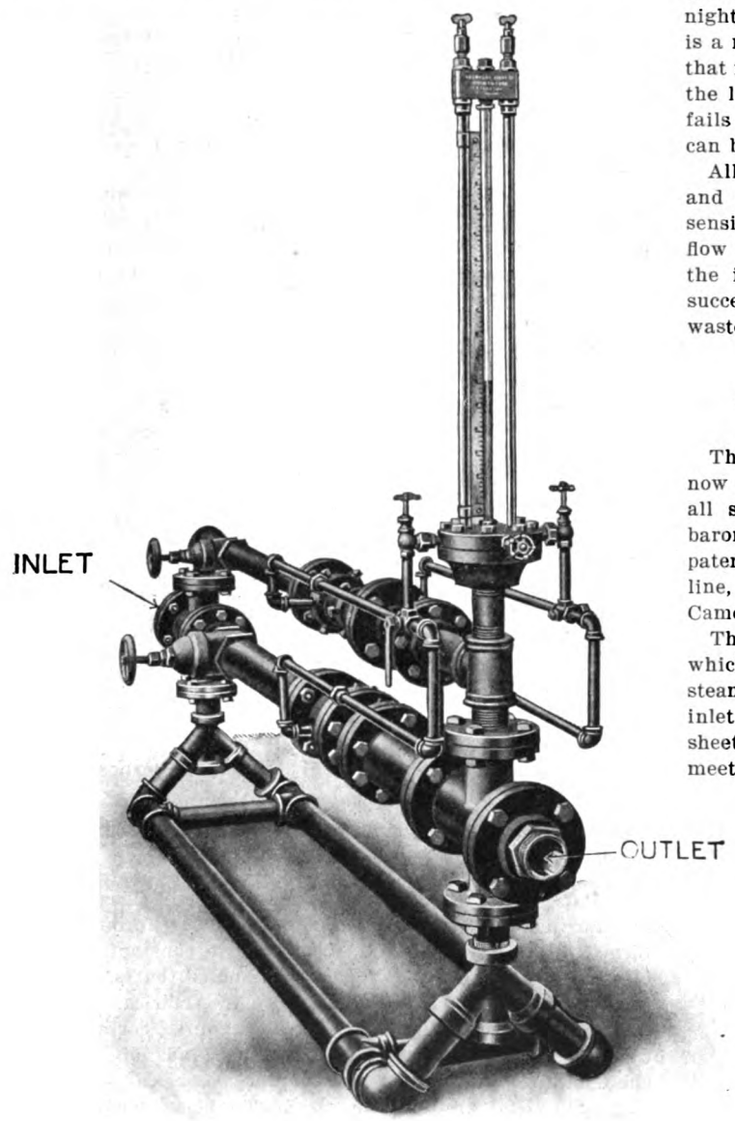
$1.17 \times 0.141 \times 2\frac{1}{2} = 0.412$ cu. yd. of sand.

$1.17 \times 0.19 \times 5\frac{1}{2} = 1.22$ tons of rock.

$1.17 \times 0.141 \times 5\frac{1}{2} = 0.91$ cu. yd. of rock.

THE VENTURI WASTE-DETECTOR

A useful piece of apparatus for the detection of leakage and waste from the distribution mains and services of a water system has recently been perfected by the Venturi Department of the Builders Iron Foundry, Providence, Rhode Island. It consists of two Venturi-meter tubes, having different but overlapping ranges in measuring capacity, together with a mercury manometer, the whole being mounted on frame as shown in the illustration. The smaller meter-tube is on a by-pass line above the larger tube. The manometer is of the barometric type. The inlet pressure-chamber of each meter-tube is connected by small piping to the mercury-well at the base of the instrument and the pressure from the throats of the meter tubes communicates in a similar manner with the interior of the vertical glass-tube. The mercury is thus caused to rise and fall in the glass-tube in proportion to the difference between the inlet and throat pressures. The corresponding rates of flow in gallons per minute, or other units, may be observed on the fixed scale, the graduated portion of which is 22 in. long.



THE VENTURI WASTE-DETECTOR.

When a leakage test is conducted, the street or district is isolated from the general system by closing the main shut-off valves. A hydrant on the isolated main pipe is then connected by a hose line to the outlet end of the Waste Detector. The inlet end is similarly connected to another hydrant entirely outside the district, the supply from which, therefore, must pass through the detector into the isolated main. This work can be done to the best advantage during the late hours of the night, when the use of water for domestic and other purposes is a minimum and when there is the least likelihood of drafts that may interfere with observations. Water is passed through the larger meter-tube first, and if the flow is so small that it fails to give satisfactory observations on the manometer, it can be diverted through the smaller meter tube.

All possible intermediate gates are then closed successively and the changes in the manometer readings noted. Thus sensitive observations may be secured upon the amount of flow and especially upon the changes in the rate of flow into the isolated district as the various parts of the system are successively isolated. In this way the points where leakage or waste occurs may readily be determined.

THE BEYER BAROMETRIC CONDENSER

The Ingersoll-Rand Company of 11 Broadway, New York, is now offering to the trade complete steam condensing plants for all service conditions. This equipment includes the Beyer barometric condenser, for which the company has secured the patent rights, Imperial duplex and Ingersoll-Rogler straight-line, reciprocating, dry vacuum-pumps and, where required, Cameron simplex and centrifugal pumps.

The Beyer condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above, and the air removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle-plates assisting the water to absorb to its full capacity the latent heat of the steam. The non-condensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. It is also to be noted that ample opportunity is given for the removal of the air-content of the water before it mixes with the steam. This, the manufacturer points out, not only facilitates the mixing process, but permits the removal of air and vapor at a comparatively low temperature, a distinct advantage as the reduced volume saves in vacuum pumpage horse-power. The steam inlet is of large diameter to secure low velocity, and is hooded in such a way as to discharge the steam into the centre of the condensing vessel. The air removal opening is also of ample area and is protected by a self-draining baffle and trap. This, it is said, positively prevents water being carried over into the vacuum pump. The hot waste water is discharged through the self-draining tail-pipe. This pipe straddles the hot-well and rigidly supports the condenser. The Imperial and Ingersoll-Rogler vacuum-

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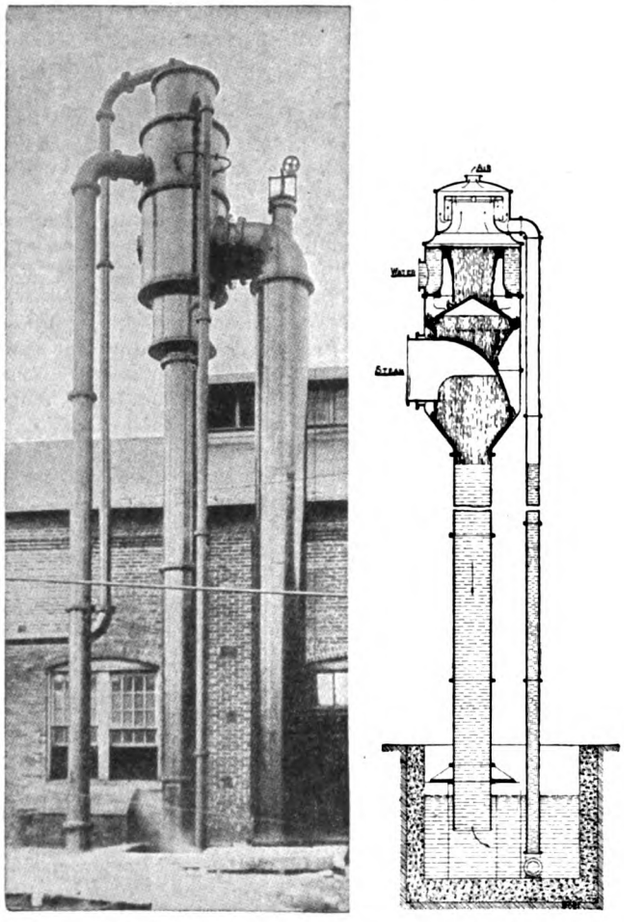
pumps are of the manufacturer's standard type. When a water-pump is required to elevate cooling water to the condenser head, Cameron pumps are provided. These may be either reciprocating or centrifugal as desired. The Ingersoll-Rand Co., however, emphasizes the fact that, where the level of the cold-well is of sufficient height above the hot-well, the



SECTION AND PHOTO OF ACTUAL INSTALLATION OF BEYER BAROMETRIC CONDENSER.

condenser will lift its own cooling water, dispensing entirely with a water-pump.

The manufacturer emphasizes the point that the vacuum and water pumps, being independently operated, can be regulated to suit varying water temperatures and conditions.

Book Reviews

BRIDGE ENGINEERING. By Dr. J. A. L. Waddell. P. 2177. Ill., index. John Wiley & Sons, New York. Price, $10. Review by Charles Evan Fowler.

This two-volume treatise covers approximately 2200 pages, and is divided into 80 chapters. It is without doubt the most notable addition to engineering literature of recent years. The author is pre-eminent in his line of work, and a review of the hundreds of notable bridges with which he has been connected would alone make a readable work. Combined with a description of other notable bridges of the world either completed or proposed, it becomes monumental in its scope. The theoretical discussions are extensive enough to give an engineer sufficient data to proceed with a design without reference to any other work, although treatises on various engineering subjects are quoted and the reader is referred to them for amplification of many subjects. The mere recitation of the subjects of the various chapters would take up more space than is usually allotted to a review, so that it will be possible to refer only to some of the more notable portions of the book. The discussion of the evolution of bridges, and the work of bridge specialists is followed by a complete résumé of all classes of bridge loadings and all phases of stress calculation. The detailed design of bridges is carefully explained. The discussion of larger bridges is especially valuable in respect to cantilevers. All of the large bridges of this type are fully described, including the author's notable design for a bridge across Havana harbor and my own for a bridge across San Francisco bay, which is referred to as the "boldest bridge design ever made." A discussion of arch spans and suspension bridges is particularly valuable, and the section devoted to movable bridges is, without doubt, the best that has ever appeared, especially in regard to the author's lift bridges, which have been constructed in all parts of the United States, and which are of a type that is particularly applicable to many locations. The discussion of materials of engineering considers the best practice, together with a full discussion of the use of alloys of steel in long span construction. The author's work in investigating and exploiting the use of nickel steel for bridges is so well known as to call for but little comment here. Should his more recent investigations along the line of vanadium steel prove to be as valuable, it may be possible to extend the span limit of great bridges much beyond the range thought possible only a few years ago. The bridge engineer will be interested in the data given about Mayari steel made by the Pennsylvania and Maryland steel companies. The laying out of bridges, the construction of foundations and piers is ably handled. The aesthetics of bridge design is taken up in a particularly interesting manner and will repay careful reading and study. The recent extensive use of reinforced concrete spans is recognized, and the subject is accorded 80 pages, forming in itself a valuable treatise on this branch of bridge design. The subject of specifications is covered in Chapters LXVIII to LXXIX. The glossary of terms in Chapter LXXX, covering about 200 pages, is remarkable in its scope and might be termed an unabridged dictionary of Bridge Engineering. The individual engineer can comprehend the character of the volumes only by reading and studying them. No engineer engaging in bridge construction can afford to be without them on his library shelves. Railroad engineers, city engineers, and others having to do with the building of bridges will find the volumes of great value.

HYDRAULIC FLOW REVIEWED. By Alfred A. Barnes. P. 152. Ill., index and 11 plates. Spon & Chamberlain, New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.50.

In Part I the author discusses the formulae of Chezy, Kutter, and Bazin for hydraulic flow and offers a new formula of the form $v = Km^a i^b$, where K, a, and b are constants for each class of pipe or channel. It should be noted that m and i are the quantities more familiarly known to American engineers under the names r and s, and that K, of course, corresponds to c in the Chezy formula. The various kinds of pipes and channels are divided into 18 different classes, and values of K, a, and b given for each class. The last two quantities are less than unity in every case. Lists of several hundred experiments by different investigators for all conditions of hydraulic flow are given, the velocity actually measured agreeing with the velocity computed from the author's formulae within a few per cent in every case.

In Part II, the author in a similar manner derives simplified formulae for the discharge from triangular and rectangular weirs and circular orifices, comparing the results derived from the formulae with those actually obtained from experiment.

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The author has done a large amount of painstaking work, and those hydraulic engineers who are not completely wedded to the use of some of the accepted formulae, are in a position to profit from it.

EARTH PRESSURE, RETAINING WALLS AND BINS. By William Cain. P. 279. Ill., index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

The design of retaining walls and bins being dependent upon the friction and cohesion, both of which are difficult to calculate, is a matter calling for a high degree of engineering skill. The tendency of the present day has been away from the earlier methods which disregarded cohesion and considered only friction. Since walls are frequently built for sand and other materials possessing little or no cohesion, the author of the present volume discusses the problem from both angles. Chapter I forms a general introduction to the entire subject. Chapter II is devoted to the calculation of stresses in non-coherent earth by graphical methods, while Chapter III gives analytical methods for the same purpose. Chapter IV considers the actual design of retaining walls. Chapter V discusses stresses in coherent earth. Chapter VI is devoted to bins, both symmetrical and unsymmetrical. The appendices discuss the stresses in wedge-shaped reinforced concrete beams and also experiment on retaining walls. The book is well illustrated and should be of value both to the student and to the practising engineer

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THE THEORY AND PRACTICE OF MODERN FRAMED STRUCTURES. By J. B. Johnson, C. W. Bryan, and F. E. Turneaure. Ninth edition, rewritten by F. E. Turneaure and W. S. Kinne. Part III. Design. P. 479. Ill., index. John Wiley & Sons, Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

The latest edition of this standard work has been rewritten by one of the surviving authors in collaboration with W. S. Kinne. The general arrangement and the topics covered are, however, similar to the old work. The subject of columns has been treated at considerable length, both from the standpoint of experiment and of theory. Secondary stresses are considered with special reference to their influence upon design. The analysis of plate-girder stresses is unusually complete. The chapters on highway bridges, roof trusses, and mill construction are comparatively brief. The complete list of chapter headings is as follows: Styles of Structures, Working Conditions, Compression Members, Combined Direct and Bending Stresses, Riveted Joints, Plate Girders, Truss Bridges, Design of a Pin-Connected Railway-Bridge, Riveted Trusses, Design of a Riveted Highway-Bridge, and Steel Railway Bridges. The appendices contain general specifications for steel railway bridges, tables of standards, and a discussion of unsymmetrical bending.

STRUCTURAL TIMBER HAND BOOK ON PACIFIC COAST WOODS. Written and compiled by O. P. M. Goss and Carl Heinmiller. P. 284. Ill., index. West Coast Lumbermens' Association, Seattle, Wash. Price, $1.

For the past few years there has been a tendency to eliminate as far as possible the use of timber in engineering structures. Part of this tendency was due to the admitted unsuitability of timber for certain structures, part was due to an exaggerated fear of exhaustion of the timber supply, part was due to the lack of care in design and construction shown by many users of timber, and part was undoubtedly due to sheer ignorance. Recently, however, a reaction has commenced. Engineers are beginning to realize that while wood is not a suitable material for an office building in a large city, it may be an excellent one for a highway-bridge floor. Even the extreme conservationists are beginning to realize that their cause is better served by improved methods of lumbering, prevention of forest fires, and the use of creosote and other preservatives, than by restricting the legitimate uses of timber. As far as ignorance is concerned, a careful perusal of the text of the present volume should be an effectual remedy, particularly with regard to Pacific Coast timber. The varieties that are discussed particularly are Douglas fir, western red cedar, western hemlock, and Sitka spruce. The properties and uses of these woods are described and some space is also devoted to creosoting processes. Most of the book is devoted to mathematical tables which, when properly used, should rob designing in timber of most of its drudgery. An idea of the comprehensiveness of the tables may be gathered from the fact that the properties of beams of every size from 2 by 4 in. up to 20 by 30 in. are given. An excellent feature of these tables is that the properties of both the rough and the surfaced section are given and also the size of the latter. A table of contents would increase the usefulness of the book, but the unusually good index makes up in part for this defect.

CONCRETE CONSTRUCTION IN RURAL COMMUNITIES. By Roy A. Seaton. P. 220. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.

This volume, as the author implies, is primarily for such users of concrete as the farmer and the small builder. The engineer and the regular concrete contractor will probably find other books of more value. However, most of the unsatisfactory experiences with concrete come from ignorance of proper methods of using it. If the small users of concrete would read and take the lessons of the present volume to heart, much of this trouble might be avoided. The book is divided into five parts. Part I discusses the materials of concrete and gives standard specifications. Part II is devoted to plain concrete, one chapter on proportioning materials, one on forms, and one on mixing and handling. A large part of Part III on reinforced concrete, is probably too technical for most of those who will use the book, but the nature of the subject compels it, and those who intend to use only the simplest systems of reinforcement can skip the rest. Part IV discusses miscellaneous matters, such as surface finish, stucco work, waterproofing and coloring, and finally casting concrete in molds. Part V discusses a number of typical applications of concrete, such as sidewalks, floors, highways, tanks, cisterns, silos, culverts, and small bridges.

CARTRIDGE MANUFACTURE. By Douglas T. Hamilton. P. 167. Index. The Industrial Press, New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.50.

SHRAPNEL SHELL MANUFACTURE. By Douglas T. Hamilton. P. 296. Index. The Industrial Press, New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $2.50.

The War has brought about what might be termed an industrial upheaval in the United States. The demands made upon the American manufacturer by the belligerents in Europe for munitions of all kinds in quantities beyond precedent have practically created in the United States a new industry over night. The manufacture of cartridges and other munitions is a highly specialized industry, calling for the use of special tools and jigs not ordinarily applicable to other lines of manufacture. The publication of Mr. Hamilton's works is especially appropriate since the American government seems fairly committed at this time toward a policy of preparedness. The engineering-society work in the preparation of an industrial census should make every manufacturer of iron and steel products in the United States interested in learning how he may adapt his own equipment to munition-manufacturing in case of emergency. These works are up to the minute and

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go thoroughly into detail in regard to all of the requirements incident to the manufacture of cartridges and shrapnel and should find a place in the reference library of every machine shop operator.

MECHANICAL ENGINEER'S HAND BOOK. By Lionel S. Marks. P. 1836. Index. McGraw-Hill Book Co., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $5.

This work has been adapted from Hütte, translated and revised by a large staff of specialists on various engineering subjects. Modifications from the original text have been made in order to adapt the subject matter to American use and conditions. It is, however, not merely a translation, as the greater part of the book, especially those portions dealing with engineering practice, is entirely new. Thirteen specialists prepared the text on the properties of engineering materials, while that on automobiles, aëronautics, illumination, patent law, cost-accounting, industrial buildings corrosion, air-conditioning, fire-protection, and prevention of accidents, has each been prepared by separate writers. Mr. Marks and his collaborators have done a splendid work in presenting this reference work for the benefit of the engineering profession.

THE ENGINEER IN WAR. By P. S. Bond. P. 176. Ill., index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.50.

This book is a revision and amplification of a series of articles that appeared recently in the *Engineering Record*. It is addressed mainly to the civilian engineer who is desirous of learning at least a little concerning the part he may be called upon to play in time of war. Any attempt, however, to write a complete treatise on military engineering is expressly disclaimed. The first two chapters deal with the military policy of the United States and with the general duties of the military engineer. The various branches of military engineering are then discussed, emphasis being placed upon the fact that, whereas the civil engineer in general aims to build a permanent structure at the lowest possible cost, the military engineer must build, in the least possible time and at whatever cost may be necessary, a temporary structure that will be serviceable. A chapter is devoted to the mobilization of material resources along the lines of the industrial preparedness census now being taken. The final chapter contains suggestions regarding ways in which engineers and contractors may fit themselves for military service in time of need, suggestions that will be much heeded by many engineers.

ENGLISH AND AMERICAN TOOL BUILDERS. By Joseph Wickham Roe. P. 315. Index. Yale University Press, New Haven, Conn. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

This is a historical work, dealing especially with the careers of the great builders of tools. It is a presentation of the human side of the evolution of machine-tool design and construction, and cannot fail to interest members of the engineering profession who can appreciate the human as well as the materialistic side of their work. The European War has created an immense demand for machine-tools of every description.

MODERN STARTING, LIGHTING, AND IGNITION SYSTEMS. By Victor W. Page. P. 509. Ill., index. Norman W. Henley Publishing Co., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $1.25.

The strides that have been made in the development of the mechanical details of motor cars have been so phenomenal that it is difficult even now to say whether or no the last word has been said on the subject of starting, lighting, and ignition. Nevertheless, the opinion is general that these phases of automobile design have been fairly well standardized. It is a far cry from the simple coil and battery ignition that was one of the chief causes of perplexity for the pioneer motorist of a few years ago, to the nearly 100%-reliable lighting, ignition, and starting units in use almost universally on the motor car of today, regardless of price. The automobile has proved to be a great educator to the layman, insofar as the operation of the motor, transmission, and differential are concerned, but the electric features still remain to a greater or less extent, a sealed book to the average motorist. Here, then, is an opportunity for those interested to understand the why and the wherefore of the electrical section of the automobile power-plant, an opportunity that should be taken advantage of by every motorist. The book is well written, in such a way as to be readily understandable by the average man. It is replete with illustrations that will facilitate a ready understanding of the text.

New Publications

THE BOILER OF 1915. By Arthur D. Pratt. P. 40. Ill. The Babcock & Wilcox Co., New York. Discusses present standard practice in boiler design and operation, particularly with regard to water-tube boilers.

ECONOMIC PAPER No 43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 1915. Compiled by Joseph Hyde Pratt and Miss F. M. Berry. North Carolina Geological and Economic Survey, Chapel Hill, North Carolina. Price, 15 cents.

TRIANGULATION IN CALIFORNIA. Bulletin No. 644-C. P. 84. Ill., index. The U. S. Geological Survey, Washington, D. C. Describes and gives the exact geographical position of 183 triangulation stations in California, together with azimuths from each of these stations to other visible stations.

REPORT OF THE CALIFORNIA STATE RECLAMATION BOARD FOR 1916. P. 36. State Reclamation Board, Sacramento. The report discusses the progress made in the construction of the Sacramento River flood-control project and in the development of the San Joaquin Valley project, as well as other subjects connected with reclamation.

THE IDEAL MORTAR FOR BRICK MASONRY. The Hydrated Lime Bureau of the National Lime Manufacturers Association, Pittsburg. P. 32. Ill., index. Discusses experiments made with various mortars. One composed of 50 lb. cement, 20 lb. hydrated lime, and 300 lb. sand gave greater strength than several containing a greater proportion of cement.

GROUND WATER IN THE SAN JOAQUIN VALLEY, CALIFORNIA. By W. C. Mendenhall, R. B. Dole, and Herman Stabler. The U. S. Geological Survey, Washington, D. C. P. 306. Ill., index. This is a revision of an earlier publication upon the same subject by the senior author. The data contained will be of value to the irrigation engineer, although too much reliance should not be placed upon the statements regarding individual wells.

HEAVY TIMBER MILL CONSTRUCTION BUILDINGS. By C. E. Paul. P. 66. Ill., index. Engineering Bureau, National Lumber Manufacturers Association, Chicago. Mill construction is here used in the restricted sense of timber construction under special recognized standards. The result should be a structure that is in many respects more fire-resisting than a poorly constructed steel building. The pamphlet discusses the design and construction of such buildings and gives a number of useful tables. While issued by an association of lumber

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manufacturers with the object of increasing the use of their product, the pamphlet can hardly be called 'trade literature' in the ordinary and somewhat derogatory sense of the term.

WOOD CONSTRUCTION IN RELATION TO FIRE LOSSES IN EUROPE AND AMERICA. P. 16. The National Lumber Manufacturers Association, Chicago. This pamphlet is devoted mainly to disproving the wild statements frequently heard regarding the higher per capita loss from fires in the United States than in Europe, attributing this to the greater use of timber in the United States. It is shown that this difference is largely due to other causes.

RULES FOR THE CONSTRUCTION OF STATIONARY BOILERS AND FOR ALLOWABLE WORKING PRESSURES. P. 114. Ill., index. The American Society of Mechanical Engineers, New York. This is the report of the so-called Boiler Code Committee appointed by the Society. Part I is devoted to rules for new installations and is divided into two sections, one dealing with power boilers and one with heating boilers. Part II deals with existing installations. The rules are complete and the book will be invaluable to anyone having to do with boiler testing or operation.

WINNIPEG RIVER POWER AND STORAGE INVESTIGATIONS. Dominion Water Power Branch, Department of the Interior, Ottawa, Canada. In two volumes. Vol. I, p. 501. Ill., index. Vol. II, 55 topographic sheets.

This is perhaps the most comprehensive report regarding hydro-electric development of an entire drainage area containing over 50,000 square miles that has ever been published. Early in the report the statement is made that the policy of the Dominion Water Power Branch is, among other things, "to encourage desirable development of water-power resources," and the reader of this report can well believe it. The two volumes will be of interest, not only to Canadian engineers but also to all members of the profession engaged in water-power development.

Civil Service Examinations

AERONAUTIC DRAFTSMAN, August 15. Aeronautic station at Pensacola, Florida. Salary, $5.04 per day. Competitors will not be assembled for examination. Applicants must have had two years in a technical school, one year as a mechanic in a machine shop, mill or factory, and two years of office drafting, not less than six months of which should have been in connection with aeronautics. Age 20 and over. Application form 1312.

ELECTRICAL DRAFTSMAN, August 15. New York Navy Yard. Salary $3.52 to $6 per day. Competitors will not be assembled for examination. Applicants must have had a high-school educaiton and four years' practical experience, or a degree from a technical school and one years' experience in marine electrical drafting. Age 18 and over. Application form 1312.

MECHANICAL DRAFTSMAN, August 22. Vacancies in office of Chief of Ordnance, Washington, D. C. Salary, $1000 to $1200 per year. Competitors will not be assembled for examination. Applicants must have had three years' experience as mechanical draftsman or have graduated from a technical school. Age 18 and over. Application form 1312.

SUB-INSPECTOR OF RADIO TOWERS, August 23. Keyport, Wash. Salary $5.52 per day. Applicants should have had one years' experience in inspecting steel framework, not less than six months of which required ascent to at least 100 ft. Age 22 to 34. Application form 1312. Examination will be held at Chico, Eureka, Fresno, Los Angeles, Red Bluff, Riverside, Sacramento, San Diego, San Francisco, San Jose, and San Luis Obispo, Cal., Astoria, Baker, Bend, Corvallis, Eugene, Grants Pass, Klamath Falls, Marshfield, Pendleton, Portland, and the Dalles, Oregon, and Aberdeen, Bellingham, Centralia, North Yakima, Pasco, Port Townsend, Pullman, Raymond, Seattle, Spokane, Tacoma, Vancouver, Walla Walla, and Wenatchee, Washington.

SCIENTIFIC ASSISTANT IN OCEANOGRAPHY, August 23. Bureau of Fisheries, Washington. Salary, $900. Applicants should have had three months' experience in hydrographic investigations and hydrographic drafting. Age 20 to 34. Application form 1312. Places of examination same as for preceding position.

LABORATORY ASSISTANT, August 23-24. Bureau of Standards, Washington. Salary, $900 to $1200. Applicants must be university graduates, or expect to graduate within six months of the time of taking the examination. It is especially desired to secure eligibles qualified in advanced general physics and civil and mechanical engineering. Age 20 to 34. Application form 1312. Places of examination same as for preceding position. This examination will also be held October 11-12.

INSPECTOR OF SAFETY APPLIANCES, August 28-29. Interstate Commerce Commission. Salary, $1800 and traveling expenses. Applicant should have had eight years' experience in steam railroad service. Age 25 to 49. Application form 1933. Places of examination same as for preceding position.

SUPERVISING MARINE ENGINEER, August 29. Office of Quartermaster General, War Department, Washington, D. C. Salary, $3500. Competitors will not be assembled for examination. Applicants must have graduated from a technical school and have had eight years' subsequent experience in design, construction, or operation of vessels, at least two years of which should have been of a supervisory character. Age 25 to 54. Application form 2118.

EXPLOSIVES CHEMIST, September 12. Ordnance Department, Frankford Arsenal, Philadelphia. Salary, $3000. Competitors will not be assembled for examination. Applicants must have graduated in chemistry from a technical school and have had five years' experience in handling, testing, and manufacture of explosives. Age under 40. Application form 2118.

COMPUTER, COAST AND GEODETIC SURVEY, September 13-14. Applicants will be examined in pure mathematics and practical computations. Age 20 and over. Application form 1312. Places of examination same as for Sub-Inspector of Radio Towers.

MACHINIST, October 1. Navy Yard, Washington, D. C. Non-educational examination. Salary, $3.28 to $4.24 per day. High-grade machine work in manufacture of ordnance materials. Application form 1800, which may be obtained from the Labor Board, Navy Yard, Washington, D. C. Form should be filed before September 16.

AID, BUREAU OF STANDARDS, October 11-12. Salary, $600 to $720. Applicants must be high school graduates. Age 19 to 24. Application form, 1312. Places of examination same as for Sub-Inspector of Radio Towers.

MECHANICAL DRAFTSMAN, October 11-12. Panama Canal Service. First-class draftsmen must have had three years' drafting experience and some shop experience. Second-class draftsmen must have had two years' drafting experience or one year shop and one year drafting-room. Graduation from a technical school will count as two years' experience in both cases. Age 20 to 45. Application form 1312. Places of examination same as for Sub-Inspector of Radio Towers.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

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Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Charles McGonigle, president, care Western Sheet Metal Works.

San Francisco Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, secretary, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. W. K. Barnard, secretary, 701 Central building, Los Angeles.

Coming Conventions

AMERICAN ELECTRIC RAILWAY ASSOCIATION. Annual convention, Atlantic City, New Jersey, October 9-13. E. B. Burritt, secretary, 8 West 40th street, New York.

AMERICAN GAS INSTITUTE. Annual meeting, Chicago, October 17-20. G. G. Ramsdell, secretary, 29 West 39th street, New York.

AMERICAN INSTITUTE OF METALS. Annual meeting, Cleveland, Ohio. Week of September 11. W. M. Corse, secretary, 106 Morris avenue, Buffalo, New York.

AMERICAN PEAT SOCIETY. Annual meeting, Washington, D. C., September 21-23. Julius Bordello, secretary, Kingsbridge, New York.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Annual convention, Newark, New Jersey, October 9-13. Charles C. Brown, secretary, Indianapolis, Indiana.

ILLUMINATING ENGINEERING SOCIETY. Annual convention, Philadelphia, September 18-20. C. D. Fawcett, assistant secretary, 29 West 39th street, New York.

Personal

W. R. ARMSTRONG has been appointed assistant chief engineer for the Union Pacific Railway.

G. F. NICHOLSON has succeeded JUDSON R. WEST as chief engineer for the Seattle Port Commission.

B. P. LEGARÉ was marshal of the engineers' division in the preparedness parade at San Francisco July 22.

PAUL P. WHITHAM, consulting engineer of Seattle, has been authorized to recruit a company of engineers in that vicinity.

C. A. KIERNAN, superintendent of streets at Monterey, California, has announced his candidacy for county supervisor.

A. E. CHANDLER addressed the members of the Engineers' Club of San Francisco on the 'California Water Commission Act' on July 6.

BARRY DIBBLE, formerly electrical engineer for the Minidoka, Idaho, project of the U. S. Reclamation Service, has been appointed project manager.

EDWARD I. CLAWITER, formerly engineer for Miller & Lux, Inc., has resigned to become engineer for the San Francisco Bridge Co. with headquarters at San Francisco.

H. V. CARTER has disposed of his holdings in the Pacific States Electric Co. and has resigned as president and general manager. T. E. BIBBINS has been elected president.

OLMSTEAD & GILLELEN, consulting engineers of Los Angeles, have been retained by the city of Santa Barbara to design the proposed outfall sewer and disposal plant for that city.

The following officers have been elected for the ensuing year by the Los Angeles Section of the American Society of Mechanical Engineers: W. A. E. NOBLE, chairman; RALPH SPRADO, vice-chairman; FORD W. HARRIS, secretary; W. A. E. NOBLE, RALPH SPRADO, FORD W. HARRIS, LLOYD GILBERT, and O. J. ROOT, executive committee.

FRANK G. WHITE, formerly chief assistant engineer for the California State Board of Harbor Commissioners, has succeeded JEROME NEWMAN, as chief engineer for that body.

HANS MUMM, JR., D. W. MCMORRIS and L. A. NICHOLSON have been appointed a committee to prepare plans for a permanent organization of city engineers in the State of Washington.

STEPHEN T. MATHER, Assistant Secretary of the Interior, delivered an address on 'Good Roads' at a luncheon given by the Oakland, California, Chamber of Commerce on August 4.

S. H. FINLEY, who has been chief engineer for the Orange County, California, Highway Commission, has announced his candidacy for supervisor from the First district in that county.

FLOYD W. ALLEN, formerly deputy county engineer for King county, Washington, has resigned to become chief engineer for Water District No. 2, comprising 7000 acres in the vicinity of Seattle.

GEORGE W. SPENCER, city engineer of Huntington Beach, California, has been appointed city manager. He will continue to perform his old duties and also have charge of city affairs in general.

THOMAS G. BUSH, formerly assistant highway commissioner for the State of Washington, has organized the firm of THOMAS G. BUSH & CO., contractors, with headquarters at Spokane.

J. H. LEARY, formerly superintendent of transportation for the Oakland, Antioch & Eastern Railway, has resigned that position to become assistant superintendent of transportation for the Western Pacific Railway.

The first company of Engineers of the National Guard of California has been organized and mustered into the Federal service. J. A. GIVENS, Sacramento, is captain, and A. M. BARTON, Bakersfield, and J. P. JONES, Sacramento, are first lieutenants. The company will soon be sent to Nogales, Arizona.

Obituary

W. A. MCGOVERN, general manager of the Northern Electric Railroad, died July 15 at Lake Tahoe, where he had gone for a brief vacation.

DON J. WHITTEMORE, one of the oldest and most prominent railroad engineers in the United States, died July 16 at his home in Milwaukee. He entered railroad work in 1847 and became chief engineer of the Chicago, Milwaukee & St. Paul Railroad in 1863, which position he held until his retirement in 1910, when the honorary position of consulting engineer was created for him. He was a past-president of the American Society of Civil Engineers.

Commercial Paragraphs

The VULCAN SOOT CLEANER CO., Du Bois, Pennsylvania, has published an interesting booklet concerning soot and methods for its removal.

The NORDBERG MANUFACTURING CO., Milwaukee, has published Bulletin No. 28, describing the poppet-valve engines manufactured by the company and the kind of service for which each model is best fitted.

NORMAN B. LIVERMORE & CO., San Francisco, have recently been appointed agents for T. L. Smith Co., Milwaukee, for their entire line of paving and concrete-mixing machinery. Stocks will be carried in San Francisco and all California business will be handled through this agency. Until recently they were agents for the Ransome mixer, but have discontinued this line and will handle the Smith mixer exclusively.

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SAN FRANCISCO, AUGUST 7, 1916

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CONTRACTS PENDING

Bids will be Received		See Issue of News Bulletin
Aug. 7.	Colfax, Wash., Bridges	July 17
Aug. 7.	Fresno, Cal., Street Signs	July 31
Aug. 7.	Hanford, Cal., Coal	July 31
Aug. 7.	Hanford, Cal., Road Work	July 24
Aug. 7.	Lewiston, Ida., Road Work	July 17
Aug. 7.	Olympia, Wash., Road Work	July 24
Aug. 7.	Phoenix, Ariz., Supplies	Aug. 7
Aug. 7.	Portland, Ore., Sea-wall	July 31
Aug. 7.	Redwood City, Cal., Road Work	July 31
Aug. 7.	Sacramento, Cal., Building	July 24
Aug. 7.	Salinas, Cal., Street Work	July 24
Aug. 7.	San Jose, Cal., Street Work	Aug. 7
Aug. 7.	South San Francisco, Cal., Street Work	Aug. 7
Aug. 7.	Victorville, Cal., Building	Aug. 7
Aug. 7.	Wasco, Cal., Building	July 24
Aug. 7.	Woodland, Cal., Water Supply	July 24
Aug. 8.	Auburn, Cal., Bridge	Aug. 7
Aug. 8.	Bakersfield, Cal., Road Work	July 24
Aug. 8.	Berkeley, Cal., Street Work	July 31
Aug. 8.	Colusa, Cal., Bridges	July 17
Aug. 8.	Fresno, Cal., Light	July 17
Aug. 8.	Menlo Park, Cal., Sewers	July 31
Aug. 8.	Republic, Wash., Road Work	July 17
Aug. 8.	Sacramento, Cal., Street Work	Aug. 7
Aug. 8.	San Rafael, Cal., Automobile	July 31
Aug. 8.	San Rafael, Cal., Building	July 24
Aug. 8.	San Rafael, Cal., Light	Aug. 7
Aug. 8.	Seattle, Wash., Building	July 31
Aug. 8.	Seattle, Wash., Drainage Ditches	July 31
Aug. 8.	Shelton, Wash., Road Work	July 31
Aug. 8.	Stockton, Cal., Sewer	July 17
Aug. 8.	Ukiah, Cal., Road Work	July 31
Aug. 8.	Ventura, Cal., Road Work	July 31
Aug. 9.	Bakersfield, Cal., Bridge	July 17
Aug. 9.	Modesto, Cal., Street Work	Aug. 7
Aug. 9.	Red Bluff, Cal., Bridges	July 31
Aug. 9.	Riverside, Cal., Road Work	Aug. 7
Aug. 9.	San Francisco, Cal., Power	Aug. 7
Aug. 9.	San Francisco, Cal., Tunnels	July 31
Aug. 9.	Sheridan, Mont., Water Supply	July 17
Aug. 10.	Bakersfield, Cal., Building	July 24
Aug. 10.	Portland, Ore., Supplies	Aug. 7
Aug. 10.	Spokane, Wash., Building	Aug. 7
Aug. 10.	Washington, D. C., Oils	July 31
Aug. 10.	Waterville, Wash., Bridge	July 24
Aug. 10.	Waterville, Wash., Road Work	July 24
Aug. 11.	Seattle, Wash., Building	July 24
Aug. 12.	Miles City, Mont., Bridge	July 31
Aug. 12.	Tracy, Cal., Miscellaneous	Aug. 7
Aug. 12.	Washington, D. C., Machinery	July 17
Aug. 14.	Everett, Wash., Bridge	July 31
Aug. 14.	Fresno, Cal., Building	Aug. 7
Aug. 14.	Globe, Ariz., Road Work	Aug. 7
Aug. 14.	Los Angeles, Cal., Water System	Aug. 7
Aug. 14.	Malta, Mont., Irrigation	July 24
Aug. 14.	Sausalito, Cal., Sewer	Aug. 7
Aug. 15.	Chino, Cal., Sewers	July 31
Aug. 15.	Santa Rosa, Cal., Street Work	July 24
Aug. 15.	Vallejo, Cal., Street Work	July 31
Aug. 15.	Washington, D. C., Machinery	Aug. 7
Aug. 16.	San Francisco, Cal., Supplies	Aug. 7
Aug. 16.	Santa Rosa, Cal., Road Work	Aug. 7
Aug. 17.	Oakland, Cal., Street Work	Aug. 7
Aug. 17.	Florence, Ariz., Bridge	July 31
Aug. 17.	Powell, Wyo., Irrigation	July 24
Aug. 19.	Placerville, Cal., Street Work	Aug. 7
Aug. 21.	Colfax, Wash., Road Work	July 31
Aug. 21.	Los Angeles, Cal., Road Work	Aug. 7
Aug. 21.	Sacramento, Cal., Bridge	Aug. 7
Aug. 21.	San Jose, Cal., Bridge	July 24
Aug. 21.	San Jose, Cal., Road Work	July 31
Aug. 21.	San Jose, Cal., Street Work	Aug. 7
Aug. 22.	Salt Lake City, Utah, Street Work	Aug. 7
Aug. 22.	South Bend, Wash., Bridges	Aug. 7
Aug. 22.	South Bend, Wash., Road Work	Aug. 7
Aug. 22.	Washington, D. C., Machinery	Aug. 7
Aug. 28.	Portland, Ore., Supplies	Aug. 7
Aug. 28.	San Bernardino, Cal., Bridges	Aug. 7
Aug. 31.	Napa, Cal., Bridge	Aug. 7
Sept. 1.	Modesto, Cal., Building	Aug. 7
Sept. 2.	Washington, D. C., Building	Aug. 7
Sept. 20.	Sydney, Australia, Machinery	July 24
Oct. 11.	Sydney, Australia, Machinery	July 24

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Construction News

STREET AND ROAD WORK

Alameda, Cal.—Bids will be received until August 15 by R. E. Bosshard, city clerk, for grading and construction of asphaltic concrete wearing surface on concrete base, concrete curbs and gutters, and corrugated-iron culverts on Central avenue.

Berkeley, Cal.—Contract for laying cement sidewalks on Carlton street has been awarded to the Oakland Paving Co., 5000 Broadway, Oakland.

Contract for grading and construction of macadam pavement and concrete curbs and gutters on Keith avenue has been awarded to Oakland Paving Company.

Contract for improving Tamalpais, Shasta, and Tallac streets has been awarded to Johnson-Shea Company.

Eureka, Cal.—Proposed bond issue of $1,500,000, which is to be voted upon August 29, provides for the construction of a county highway system comprising 52½ miles of paved highways and 213 miles of mountain roads. The paved highways are to be 16 ft. with a 5-in. concrete base and 1½-in. asphaltic concrete wearing surface. The mountain roads are to be 12 ft. wide with turnouts and are to be graded and provided with the necessary drainage and culverts.

Globe, Ariz.—Bids will be received until August 14 by Board of Supervisors for construction of five miles of concrete pavement on Globe-Miami highway and one mile on Winkelman-Hayden highway. R. G. Thomas is county engineer. This is the first contract on the $350,000 county highway system to be advertised.

Los Angeles, Cal.—Board of Supervisors will receive bids until August 21 for construction of 2.07 miles of macadam highway with bituminous surface within city limits of Burbank. County furnishes rock, oil, and screenings. Estimated cost is $4504.15.

Board of Supervisors will receive bids until August 21 for construction of 10.63 miles of concrete pavement on section D of Mint Canyon highway. Estimated cost is $132,885.25.

Contract for construction of 2.08 miles of concrete pavement on disintegrated granite base has been awarded to A. L. McCray, 234 West 28th street, for $11,380. County furnishes cement, sand, gravel, and oil.

Madera, Cal.—Contract for construction of sidewalks, curbs, and retaining wall at high-school grounds has been awarded to A. Gendron at $0.11 per sq. ft. for sidewalks and $0.29 per lin. ft. for curbs.

Martinez, Cal.—Contract for construction of pavement on Main street has been awarded to M. F. Sullivan.

Modesto, Cal.—Bids will be received until August 9 by W. O. Thompson, city clerk, for grading and construction of asphaltic concrete pavement and concrete curbs and gutters on several streets.

Oakland, Cal.—Bids will be received until August 17 by L. W. Cummings, city clerk, for grading and construction of redwood curbs, concrete gutters, cement sidewalks, oil macadam pavement, corrugated iron and concrete culverts, and an 8-in. sewer on 75th avenue.

Contract for improvement of Laurel avenue has been awarded to Ransome-Crummey Co., First Savings Bank building.

Contract for improvement of Thompson street has been awarded to Hutchinson Co., 13th and Franklin streets.

Lincoln Highway Association proposes to raise $100,000, $50,000 in northern California and $50,000 in Nevada, for improvement of Lincoln highway in Nevada, from Ely west. Joseph E. Caine, secretary Oakland Chamber of Commerce, is Lincoln highway consul for California.

Placerville, Cal.—Bids will be received until August 19 by city clerk for paving Main street. Estimated cost is $30,000.

Porterville, Cal.—Contract for grading 20 miles of road-bed for Visalia Electric Railroad Co. and Southern Pacific Co. in this vicinity has been awarded to Robert Sherer & Co., Pacific Electric Bdg., Los Angeles.

Redlands, Cal.—City trustees will construct 1½ miles of pavement on Reservoir street. County will furnish rock.

Riverside, Cal.—Board of Supervisors will receive bids until August 9 for paving ½ mile of highway in town of Hemet.

Sacramento, Cal.—Bids will be received until August 8 by M. J. Desmond, city clerk, for grading and construction of asphaltic macadam pavement and vitrified pipe-drains on several alleys.

Contract for grading and construction of asphaltic concrete pavement on concrete base for three blocks on Third street has been awarded to McGillivray Construction Company.

Contract for improvement of J street has been awarded to Clark & Henery Construction Company.

Contract for improvement of Madrone avenue has been awarded to A. Teichert & Son.

Contract for improvement of Fourth avenue has been awarded to Clark & Henery Construction Company.

Salt Lake City, Utah.—Bids will be received until August 22 by Gordon Snow, city recorder, for construction of pavement on several streets. Plans from S. Q. Cannon, city engineer, upon deposit of $5.

Contract for construction of bituminous concrete and bitulithic pavement on several streets has been awarded to Strange & Maguire Paving Co. for $75,844.

Contract for paving several streets has been awarded to P. J. Moran for $15,938.08.

San Francisco, Cal.—Following street work has been ordered: grading and construction of sidewalks, curbs, sewers, catch-basins, and asphalt pavement on Balboa street; sewers on De Haro street; curbs and basalt pavement on Casselli avenue; curbs and brick and asphalt pavement on Cabrillo street; sidewalks on 12th avenue; curbs, sidewalks, and asphalt pavement on Silliman street and on 44th avenue; sewers and brick pavement on Mono street; grading on 28th avenue.

Contract for construction of concrete pavement with asphaltic concrete wearing surface on Monterey boulevard and adjacent streets has been awarded to Blanchard-Brown Co., 660 Market street, at $0.118 and $0.12 per square foot.

San Jose, Cal.—Bids will be received until August 7 by city clerk for construction of one block of pavement on First street.

Bids will be received until August 21 by H. A. Pfister, county clerk, for improvement of Campbell avenue.

Bids will also be received until the same time for improvement of San Martin avenue. I. L. Ryder is county surveyor.

Bids will be received until August 21 by Board of Supervisors for construction of 7863 lin. ft. of concrete base pavement with 1½-in. asphaltic surface on Lincoln avenue.

Bids will also be received until the same time for gradng and rollng 14,241 lin. ft. of Lawrence Station road, and for construction of 6508 lin. ft. of oil macadam pavement on same. I. L. Ryder is county surveyor.

Santa Ana, Cal.—Contract for paving several alleys has been awarded to Wells & Bressler.

Santa Rosa, Cal.—Bids will be received until August 16 by W. W. Felt, Jr., county clerk, for re-surfacing about seven miles of highways in various parts of the county. M. P. Youker is county surveyor.

Seattle, Wash.—Contract for paving East Marginal way has been awarded to Holt & Jeffery, Transportation Bdg., for $114,149.

Contract for planking Rainier avenue has been awarded to Hanson & Vatne, 105 North 84th street, for $15,953.

Contract for construction of concrete walks on several streets has been awarded to Silverton & Williams, 2823 South J street, Tacoma, for $8175.90.

Selma, Cal.—City trustees are having plans prepared for paving streets.

South Bend, Wash.—Bids will be received until August 22 by County Commissioners for construction of 4800 lin. ft. of water-bound macadam near Chinook, 1000 lin. ft. of Chinook Depot highway, and 6000 ft. of North Cove Extension highway. Plans from county engineer Chas. B. Nims, upon deposit of $2 for each set.

South San Francisco, Cal.—Bids will be received until August 7 by board of trustees for grading and constructon of asphaltic concrete pavement, concrete curbs and sidewalks, and storm sewers on Commercial avenue and cross streets. George A. Kneese is city engineer.

Stockton, Cal.—Clark & Henery Construction Co. was low bidder at $3247.91 for paving Weber levee. Engineer's estimate was $3916.15.

Walla Walla, Wash.—Contract for construction of three miles of gravel highway west of Touchet has been awarded to L. L. Lanning for $17,000.

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SEWERS AND DRAINAGE

Healdsburg, Cal.—City Council has decided to construct three septic tanks by day labor. Work will be done under the direction of W. H. Castner, Jr. Material will be purchased in the open market.

La Grande, Ore.—Contract for construction of sewer system has been awarded to G. Gordon, Portland, for $15,567.40.

Oakland, Cal.—Contract for construction of Beck Street storm sewer has been awarded to Baker & Martin, 310 Sheldon Bdg., San Francisco, for $8777.77. The unit prices were: 3 ft. x 3 ft. 6 in. concrete arch-culvert, $3.57 per lin. ft.; 2 ft. 6 in. x 4 ft. concrete box-culvert, $4.11; 2 ft. 9 in. x 5 ft. concrete box-culvert, $4.32; 3 ft. 6 in. x 6 ft. concrete box-culvert, $6.63; taper sections of culverts 10 ft. long, $40.50 each; 24-in. pipe conduit, $2.36 per ft.; re-laying existing 12-in. conduit, $1.44; 10-in. conduit, $1.61; manholes, $27 each; storm-water inlets, $29.80. Other bidders were: E. H. Sundberg, $8857; Karl Ehrhart, $9152.60; Bates, Borland & Ayer, $9447.19; R. Mathieson, $9790; F. Ostrander, $9807.10.

Contra Costa Construction Co. was low bidder at $9197.50 for construction of concrete outfall sewer on Linden street. Unit prices were: concrete sewer, $14.90 per ft.; piles, $13 each; brace piles, $20 each; lumber in place, $60 per 1000 ft. Other bidders were: C. H. & A. W. Gorrill, $9298; M. Murphy, $10,064; R. Mathieson, $11,112; F. Ostrander, $11,260.75.

Richmond, Cal.—City Coucil has entered into agreement with Bay Counties Land Co. for reclamation of land and construction of channel at foot of 10th street. City will spend about $75,000 on bulkhead and company will pump 200,000 cu. yd. of material for fills. H. D. Chapman is city engineer.

Riverside, Cal.—Contract for construction of system for drainage district No. 2, including 450,000 cu. yd. excavation, has been awarded to J. E. Winship for $52,700.

Sacramento, Cal.—Plans are being prepared for construction of levee from Southern Pacific tracks southerly to Lower Stockton road.

Sausalito, Cal.—Bids will be received until August 14 by W. Z. Tiffany, town clerk, for construction of 329 ft. of vitrified pipe sewer on West street, with 2 lampholes and 14 wye-branches. L. L. Hohl is town engineer.

Stockton, Cal.—Chambers & Heafy, Bacon Bdg., Oakland, were low bidders at $11,993.61, for construction of sewers in North Stockton. Other bidders were: W. F. Edwards, $13,422.24; Frank C. McIntire, $14,180.97. Engineer's estimate was $14,767.49.

W. F. Edwards, 675 31st street, Oakland, was low bidder at $7701.16 for construction of sewers in district north of Fremont street. Chambers & Heafy bid $8166.10. Engineer's estimate was $7745.

BRIDGES AND CULVERTS

Auburn, Cal.—County clerk will receive bids until August 8 for construction of wooden bridge with concrete piers and abutments across Auburn ravine.

Bakersfield, Cal.—Contract for construction of 150-ft. pile trestle bridge over Buttonwillow slough has been awarded to S. G. Smartt for $2184. Castro & Blaisdell bid $3290.

Grass Valley, Cal.—All bids for construction of concrete bridge over Dry creek near Spenceville have been rejected and work will be re-advertised.

Napa, Cal.—Bids will be received until August 31 by N. W. Collins, county clerk, for construction of abutments and wing-walls for bridge across slough near Rutherford.

Oakland, Cal.—Contract for construction of reinforced concrete bridge in Cull Canyon road has been awarded to Western Construction Co. for $4895. Other bidders were: Thurston & Russell, $4955; M. E. Fernandez, $5120; Baker & Martin, $5277; W. H. London, $6216; John Doyle, $6571; and Whitlock & Gorrill, $6844.20.

Riverside, Cal.—Contract for construction of Santa Clara river bridge at West Riverside has been awarded to Mercereau Bridge & Construction Co., Pacific Electric Bdg., Los Angeles, for $9500. Other bidders were: Security Construction Co., $10,983; W. M. Ledbetter & Co., $11,460; and Mesmer & Rice, $11,533.

Sacramento, Cal.—State Highway Commission will receive bids until August 21 for construction of steel bridge on State highway across Santa Ynez river in Santa Barbara county, comprising five 162-ft. spans. Work includes excavation and backfilling for piers, 23,500 cu. yd. embankment, 2000 cu. yd. riprap, 39,000 lin. ft. Douglas fir piles, 87,500 ft. B.M. lumber, 375 cu. yd. class A concrete, 1350 cu. yd. rubble concrete, 51 tons reinforcing steel, and 460 tons structural steel. State will furnish cement, sand, gravel, barbed wire, and staples. Plans may be seen at office of Commission or at office of division engineers in San Francisco and Los Angeles. They may be obtained from the Commission upon payment of $1.35. Checks should be made payable to Forrest Blue Print Company.

Contract for construction of two bridges on State highway in Shasta county, which was awarded to H. S. Williams, has been rescinded and the work awarded to Ross Construction Co., Sacramento, for $24,676.38. The bridges are of reinforced concrete, one 541 ft. long and the other 120 ft. long.

Salt Lake City, Utah.—Contract for construction of concrete bridge over Jordan river at 51st South street has been awarded to John Holt for $6700.

San Bernardino, Cal.—Bids will be received until August 28 by Board of Supervisors for construction of two riveted-steel highway bridges across Santa Ana river.

Pacific Electric Railway will construct reinforced concrete bridge across Santa Ana river. Estimated cost is $30,000. Work wll be done by company forces.

South Bend, Wash.—Bids will be received until August 22 by County Commissioners for construction of 40-ft. reinforced concrete bridge near Globe and 75-ft. reinforced concrete bridge near Lebam. Plans from Charles B. Nims, county engineer, upon deposit of $2 for each set.

IRRIGATION AND WATER SUPPLY

Coeur d'Alene, Ida.—Election has been called for August 28 to vote on bond issue of $280,000 for construction of municipal light and water plant.

Fresno, Cal.—Construction of reservoir in Tulare lake containing 20,000 acres and having levees 20 ft. high is proposed. Water is to be used for irrigation. A. G. Wishon is interested.

Los Angeles, Cal.—Board of Supervisors will receive bids until August 14 for construction of water system near Norwalk in Los Angeles Water Works District No. 2, including 21,700 ft. of 4 and 6-in. pipe, drilling well, and installing a pumping plant.

Bond issues for $300,000 in Mission land distrct and for $1,020,000 in Hollywood-Colegrove district, both for water systems, have been declared illegal because of technicalities, and new elections will have to be held.

Modesto, Cal.—State engineer W. F. McClure has approved plans for Waterford irrigation district. Bond issue of $465,000, $254,000 for purchase of water rights and $211,000 for construction of system, is proposed. L. L. Dennett is attorney.

Salem, Ore.—John H. Lewis, State engineer, and John T. Whistler of the U. S. Reclamation Service have prepared plans for draining and irrigating 60,000 acres of land in Warner valley, Lake county, at an estimated cost of $1,726,000 and for irrigating 36,000 acres of land along White river, Wasco county, at an estimated cost of $1,300,000.

San Diego, Cal.—Contract for construction of south dike at Sweetwater reservoir has been awarded to C. L. Hyde Construction Co., Spreckels Bdg., for $10,000.

Contract for enlargement of south spillway and of north spillway at Sweetwater reservoir has been awarded to H. G. Fenton, Central Mortgage Bdg., for $70,000.

LIGHT, HEAT, AND POWER

San Francisco, Cal.—Bids will be received until August 9 by Board of Public Works for furnishing machinery for power-plant to be constructed on Tuolumne river to furnish power for Hetch-Hetchy construction operations.

San Rafael, Cal.—Board of Supervisors will receive bids until August 8 for construction of lighting system in Laverne lighting district.

Visalia, Cal.—Central California Gas Co. will spend about $50,000 in additions to system.

RAILROAD WORK

Oatman, Ariz.—Plans are being prepared for construction of railroad to Topock on Santa Fe Railroad. E. R. Hibbard, 332 South Michigan avenue, Chicago, is interested.

Tacoma, Wash.—Contract for construction of substructure for dock for Chicago, Milwaukee & St. Paul Railroad has been awarded to J. A. McEachern Co., Inc., Bell Street dock, Seattle. The railroad company will construct superstructure by day labor.

BUILDING CONSTRUCTION

Alturas, Cal.—Contract for construction of distributing station for Standard Oil Co. has been awarded to J. C. Jarman. There well be five buildings and three foundations for steel tanks.

Fellows, Cal.—Election has been called for August 25 to vote

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on bond issue of $20,000 for construction of school building.

Fresno, Cal.—Bids will be received until August 14 by J. M. Euless, clerk board of school trustees, 2140 Tulare street, for construction of tank-house, plumbing, and repairs of Easterby school house.

Fullerton, Cal.—Election has been called for August 25 to vote on bond issue of $35,000 for construction of swimming-pool, manual training building, and garage at high school.

Hollister, Cal.—Old Mission Portland Cement Co. will construct plant near San Juan.

Modesto, Cal.—Bids will be received until September 1 by board of education for construction of school building. Estimated cost is $33,000.

Salt Lake City, Utah.—J. H. Angell was low bidder at $43,956 for construction of Forest Dale school.

Spokane, Wash.—Bids will be received until August 10 by city council for construction of crematory. Estimated cost is $30,000.

Tacoma, Wash.—Feist & Bachrach will construct $55,000 building. Heath & Gove are architects.

Taft, Cal.—Bond issue of $18,000 for enlargement of school building in Conley district has been voted.

Victorville, Cal.—School trustees will receive bids until August 7 for construction of building for high school. Hibbard & Cody, 1200 Marsh-Strong Bdg., Los Angeles, are architects. Estimated cost is $27,500.

Visalia, Cal.—Contract for construction of Cross-Lillie building has been awarded to R. Pedersen, Fresno, for about $12,000.

Washington, D. C.—Bureau of Yards and Docks, Navy Department, will receive bids until September 2 for construction of ice-making and cold-storage plant for United States marine barracks, Pekin, China.

Contract for construction of post-office building has been awarded to Campbell Building Co., Salt Lake City, Utah, for $82,787, using sandstone.

Woodland, Cal.—Contract for remodeling flour mill of Globe Milling Co. into rice-milling plant has been awarded to W. B. Schuyler, San Francisco. Estimated cost is $50,000.

MACHINERY AND SUPPLIES

Berkeley, Cal.—Fire Chief G. Sidney Rose has recommended purchase of pulmotor, 1000 ft. of 2½-in. fire-hose, and a roadster automobile, also the installation of five additional fire-alarm boxes.

Phoenix, Ariz.—City clerk will receive bids until August 7 for furnishing 400 ft. of 10-in. and 1000 ft. of 6-in. class B cast-iron pipe, together with several specials.

Portland, Ore.—Bids will be received until August 10, by city purchasing agent, City Hall, for furnishing 2200 ft. of 2½-in. fire-hose and 600 ft. of 1½-in. hose.

Bids will be received until August 28 at U. S. Engineer Office for furnishing stone for jetty construction at mouth of Columbia river.

Ray, Ariz.—Ray Hercules Co. will construct $300,000 generator.

Redwood City, Cal.—City will purchase additional fire-hydrants for Redwood Highlands district.

San Francisco, Cal.—Board of Public Works will receive bids until August 16 for furnishing vitrified paving-brick for ensuing year.

Contract for furnishing stone-skips for Hetch-Hetchy project has been awarded to Edward R. Bacon & Co., 51 Natoma street.

Contract for furnishing concrete mixer for Hetch-Hetchy work has been awarded to Norris K. Davis, 400 Seventh street.

Washington, D. C.—Bureau of Supplies and Accounts will receive bids until August 15 for the following: for delivery at Mare Island, Cal., 3600 ft. ¾-in. garden hose, 144 one-quart brass oil-feeders, 500 padlocks, nine 12 by 15-in. counter scales, 22,500 ft. galvanized-steel pipe, schedule 9913; for delivery at Puget Sound, Wash., four 2-ton worm-geared chain-blocks, 1000 lb. steel nuts, 144 long-handled cast-steel shovels, schedule 9913.

Bids will also be received until August 22 for delivery of 16 four-inch safety valves, schedule 9932. Particulars from Purchasing Pay Officer, U. S. Navy Pay Office, San Francisco.

MISCELLANEOUS

Merced, Cal.—Contract for construction of concrete swimming-tank has been awarded to Halverson & Gordo, 222 20th street, for $1196.

Tracy, Cal.—Bids will be received until August 12 by W. Schlossman, president of board of trustees West Side Union high school for boring and casing 10 or 12-in. well 300 ft. deep.

Washington, D. C.—Bert Ward, 513 31st avenue, Seattle, was low bidder at $7290 for construction of wooden radio mast at naval station at North Head, Washington.

Building Permits

JULY 27

Two Story Frame Dwelling—Cost $2900. Johnson & Johnson, owners. E 22nd Ave 75 S Clement.

Two Story Frame Dwelling—Cost $2900. Johnson & Johnson, owners. E 22nd Ave 100 S Clement.

Two Story Concrete Stable and Garage—Cost $3267. Philip Kohn, owner. E 10th Ave 50 N Clement.

Two Story Frame Laundry and Living Rooms—Cost $3000. Fong Suey, owner. E Ritch 75 N Harrison.

Six Story Reinforced Concrete Warehouse—Cost $150,000. Zellerbach & Co., owners. SW Francisco and Montgomery.

JULY 28

Concrete and Pile Foundation—Cost $3500. Shell Co., of Cal., owners. NE Jefferson and Leavenworth.

JULY 29

Two Story Frame Flats—Cost $5000. Jas. H. Conner, owner. S Cabrillo 82-6 W 11th Ave.

JULY 31

Three Story Brick Tenements—Cost $30,000. Andrew Nelson, owner. NW Folsom and 9th.

Tenement Alterations and Raising—Cost $5700. Mrs. E. T. Wilson, owner. 1449 Leavenworth.

AUGUST 1

Four Story Class 'C' Apartments—Cost $50,000. Metropolis Investment Co., owners. NW Leavenworth and Post.

Two Story Frame Dwelling—Cost $3000. Mary F. Rampke, owner. E 46th Ave 236 N Anza.

Two Story Frame Apartments—Cost $5000. G. Forte and F. Anastasi, owners. SE Green and Kearny.

AUGUST 2

Raising and Additions to Flats—Cost $4500. J. Castaner, owner. 555 12th Ave.

Two Story Frame Dwelling—Cost $2500. F. Nelson, owner. NW 15th Ave and Portola Drive.

Two Story Frame Flats—Cost $5000. J. Johnson, owner. E 17th Ave 128 N Clement.

Two Story Frame Flats—Cost $5000. Wm. J. Keenan, owner. N Grove 140 W Masonic.

Two Story Frame Flats—Cost $5000. Wm. J. Keenan, owner. N Grove 165 W Masonic.

NOTICE OF PENDING PROPOSAL
DEPARTMENT OF PUBLIC WORKS, CITY OF VALLEJO, CALIFORNIA

The work described below will be done under the Improvement Act of 1911 and the Improvement Bond Act of 1915. Bids will be received by the city clerk about August 15. Notice to bidders will be issued August 5. Plans from T. D. Kilkenny, city engineer, upon deposit of $5.

ESTIMATE OF QUANTITIES

Item No.	Item	Approximate Quantity
1	Excavation	56,248 cu. yd.
2	Sidewalk sand-fill and adobe trenching	407 cu. yd.
3	Reinforced concrete retaining-wall	70 cu. yd.
4	Concrete base for asphaltic concrete pavement	754,315 sq. ft.
5	Asphaltic concrete surface one inch thick	751,715 sq. ft.
6	Asphaltic concrete surface two inches thick	2600 sq. ft.
7	Concrete brick pavement	18,326 sq.ft.
8	Concrete sidewalk	21,362 sq. ft.
9	Concrete curb	38,527 lin. ft.
10	Galvanized-steel curb-armor	1226 lin. ft.
11	Reinforced concrete guard-rail	730 lin. ft.
12	Corrugated iron culvert 6 by 16 in.	140 lin. ft.
13	Corrugated iron culvert 8 by 18 in.	1664 lin. ft.
14	Corrugated iron culvert 8 by 24 in.	68 lin. ft.
15	Corrugated iron culvert 8 in. diameter	20 lin. ft.
16	Header board	1792 lin. ft.
17	House lateral sewer 4 in.	2793 lin. ft.
18	Main sewer 6 in.	820 lin. ft.
19	Cast-iron hand-holes for culverts 16 by 16 in.	31 in number
20	Cast-iron hand-holes for culverts 18 by 24 in.	2 in number
21	Lampholes	2 in number
22	Y branches in main sewer 4 by 6 in.	34 in number

Together with all incidental expenses incurred in doing said work and making said improvement according to the provisions of the "Improvement Act of 1911."

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